MAR 23 1928

The Engineer.

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PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
25 ROAD BRIDGES for LLOYD BARRAGE.
Tenders due on the 1st May, 1928.
Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each schedule. 7974

Civil Service Commission.
FORTHCOMING EXAMINATION : MALE CARTOGRAPHERS in the Hydrographic Department of the Admiralty (19-25, with extension in certain cases). Regulations and particulars are obtainable from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W.1, together with the form on which application must be made. The latest date for the receipt of application forms is 24th May. 7688

APPOINTMENT VACANT.
SUPERIOR ESTABLISHMENT.

Applications are Invited by the Secretary to the Hon'ble the Agent to the Governor-General in Baluchistan, Public Works Department, for a POST combining the duties of ELECTRICAL, BOILER and FACTORIES INSPECTOR. Applicant must have wide theoretical knowledge of Steam and Electrical Engineering, coupled with considerable experience in both branches ; preference will be given to those having in addition some knowledge of hygiene and sanitation ; proof of qualifications is required. Pay Rs. 1000-50-1200 with the possibility of permanent employment, non-pensionable ; three years' probation, subject to three months' notice on either side, thereafter the appointment may be terminated at twelve months' notice. Travelling and out-station allowances on the usual scales as for a first-class officer ; actual expenses incurred in India for joining will be paid.
Applications to the SECRETARY, as above, at Quetta, Baluchistan, India, will be received up to 18th April, 1928, and must state last appointment held. 7858

Assistant Engineers (10) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 35 years of age, must have passed the examination for A.M.I.C.E. or possess a degree in civil engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. Must have had proper technical training and preferably have had not less than two years' subsequent experience on large engineering or municipal works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M. 254. 7956

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
7959 Newcastle-upon-Tyne.

Broadstairs and St. Peter's
URBAN DISTRICT COUNCIL.
MAIN DRAINAGE SCHEME.
CONTRACT NO. 1.
TO CONTRACTORS.
The Urban District Council of Broadstairs and St. Peter's are prepared to receive TENDERS for the CONSTRUCTION of about 2800 YARDS of STONEWARE SEWERS of 9in. and 12in. diameter, and about 930 YARDS of CONCRETE TUBE SEWERS of 18in. and 24in. diameter, together with MANHOLES, VENTILATING SHAFTS, and other appurtenant WORKS, in accordance with the plans and specification prepared by the Engineer, Mr. Godfrey M. C. Taylor, Caxton House, Westminster, S.W.
Contractors desirous of tendering may obtain copies of the general conditions, specification, bill of quantities and form of Tender from, and may inspect the drawings at the office of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender. Drawings may also be inspected at the offices of the Council at Pierremont Hall, Broadstairs.
Sealed Tenders, endorsed "Main Drainage, Contract No. 1," must be delivered to the undersigned at the Council Offices, Pierremont Hall, Broadstairs, before Twelve Noon on Saturday, the 31st day of March, 1928.
The Council do not bind themselves to accept the lowest or any Tender.
By Order of the Council,
E. F. OWEN,
Clerk to the Council.
Pierremont Hall, Broadstairs,
1st March, 1928 7919

The Engineer

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PUBLIC NOTICES

Bengal-Nagpur Railway Company, Limited.
The Directors are prepared to receive TENDERS for CARRIAGE UNDERFRAMES.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 8th March, 1928.
A fee of 10s. will be charged for each specification, which is not returnable.
Tenders must be submitted not later than Noon on Thursday, 22nd March, 1928.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By Order of the Board,
R. C. VOLKERS,
Secretary.
8th March, 1928. 7966

Bombay, Baroda and Central India Railway Company.
The Directors are prepared to receive up to Noon on Friday, 30th March, TENDERS for the SUPPLY of
1. BOLTS, NUTS, RIVETS, &c.
2. LEATHER CLOTH.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices, 91, Petty France, Westminster, S.W. 1.
7th March, 1928. 7058

Southport, Birkdale and West Lancashire Water Board.
TENDER FOR CAST IRON PIPES.
The Water Board invite TENDERS from British Manufacturers for the SUPPLY and DELIVERY to Southport of about 374 TONS of CAST IRON SPIGOT and SOCKET PIPES and SPECIALS, 15in. in diameter.
Specifications and conditions of contract may be obtained upon application to the undersigned, to whom sealed Tenders are to be delivered before 10 a.m. on Wednesday, 21st March, 1928.
The Water Board do not bind themselves to accept the lowest or any Tender.
C. BURTON EDE, M. Inst. C.E.,
Engineer and Manager.
14, Portland-street, Southport,
3rd March, 1928. 7922

PUBLIC NOTICES

County Council of the County of Argyll.
NEW TYNDRUM-BALLACHULISH ROAD.
CONTRACT NO. 2.
BRIDGE OF ORCHY TO KINGSHOUSE SECTION, 11¼ MILES.
CLEARING, FENCING, DRAINAGE, EARTHWORKS, BRIDGES, CULVERTS, WATER CARRIAGEWAY, AND OTHER WORKS.
The Council are prepared to receive TENDERS from experienced Public Works Contractors of good standing for the CONSTRUCTION of the SECOND SECTION of the NEW TYNDRUM-BALLACHULISH ROAD, from Bridge of Orchy over Mount and Rannoch Moor to the vicinity of Kingshouse. The work upon this section involves considerable amounts of excavation for the road and drainage arrangements, together with the construction of reinforced concrete bridges, culverts, &c.
Drawings and specifications may be seen on and after 12th March, 1928, at the offices of the Chief Engineer, Ballachulish East, Argyll ; the Ministry of Transport, 122, George-street, Edinburgh ; the Ministry of Transport (Roads Department), 7, Whitehall-gardens, London, S.W. 1.
Specifications, bill of quantities, form of Tender, and full information may be obtained on and after the same date at the office of the Chief Engineer, Mr. James M'Gregor, D.S.O., M.Inst. C.E., Ballachulish East, Argyll, on depositing £3 3s., which deposit will only be returned on receipt of a bona fide Tender and the return of all the documents. Cheques should be made payable to the County Council of Argyll.
A conveyance will be provided, and an engineer will meet contractors at Tyndrum L.M. and S. Railway Station at 11.10 a.m., on 20th March, 1928, to show them over the route.
Sealed Tenders, endorsed "Tender, New Tyndrum-Ballachulish Road, Contract No. 2," must be lodged with the undersigned not later than 9th April, 1928.
The Council do not bind themselves to accept the lowest or any Tender, and, in view of the special character of the work, regard will be had to the standing and experience of the several contractors tendering.
M. SINCLAIR,
County Clerk.
County Offices,
Lochgilphead, Argyll.
9th March, 1928. 7969

SITUATIONS OPEN

Engineer, Practical and Technical, Under 40 years of age, to assist in Control of Works and Garages of Firm engaged on Heavy Motor Transport. —Address, giving details of experience and training, 7926, The Engineer Office. 7926 A

PUBLIC NOTICES

City of Bradford.
ESHOLT SEWAGE DISPOSAL WORKS.
CONTRACT No. 35.
CAST IRON TROUGHING.
The Corporation of Bradford are prepared to receive TENDERS for the SUPPLY and DELIVERY of 498 Lineal Yards, Weight 144 Tons or thereabouts of CAST IRON SPIGOT and SOCKET TROUGHING.
Forms of Tender, quantities, drawings, and other particulars may be obtained at the Offices of the Sewage Works Engineer, Mr. H. Wontner-Smith, M. Inst. C.E., Esholt Hall, Shipley (Station, Apperley Bridge, L.M. and S. Rly).
The contract will be let subject to the fair contracts clauses of the Corporation, which may be seen at the Engineer's Office, and which the accepted contractor will be required to sign.
Sealed Tenders, on the forms provided, endorsed "Troughing," Contract No. 35, must be sent to the undersigned not later than Twelve o'clock Noon on the 19th March, 1928.
The Corporation do not bind themselves to accept the lowest or any Tender.
N. L. FLEMING,
Town Clerk.
Town Hall,
Bradford,
9th March, 1928. 7970

County Borough of Swansea.
MAIN DRAINAGE DEPARTMENT.
LLANSAMLET PUMPING STATION (CONTRACT No. 4A).
UNEMPLOYMENT RELIEF WORKS.
The Corporation invite TENDERS from Contractors experienced in Reinforced Concrete Work for the CONSTRUCTION of the above PUMPING STATION and incidental works.
The work consists of the following, all in Reinforced Concrete :—
Pump Chamber and Sump, 27ft. dia. by 23ft. deep.
Grit Chamber, 37ft. by 9ft. by 25ft. deep.
Superstructure, 67ft. by 20ft. by 14ft. high.
Electric Sub-station, 16ft. square by 20ft. high.
Culvert over Stream, 23ft. span by 56ft. long.
And also—
18in. dia. Cast Iron Pipes in Rising Main, 1160 yards long with tidal river outfall ; Boundary Walls and other incidental works.
Contractors desirous of tendering must notify the Chief Engineer, J. Richard Heath, Guildhall, Swansea, not later than March 29th, 1928.
All applications must be accompanied by a deposit of £5 (cheques to be made payable to the Borough Treasurer, which will be returned on the receipt of a bona fide Tender and the return of the specification and quantities intact, both of which are issued conditionally upon their being returned on or before April 16th 1928.
The general conditions, specification, bills of quantities and form of Tender will be forwarded to contractors about March 22nd, 1928. The contract drawings will be open for inspection at the office of the Chief Engineer at any time during office hours.
The lowest or any Tender will not necessarily be accepted.
Tenders shall be sent in to the undersigned by registered post, before Twelve Noon on the 16th day of April, 1928, endorsed "Llansamlet Pumping Station."
H. L. LANG-COATH,
Town Clerk.
Guildhall, Swansea.
7th March, 1928 7964

Royal Burgh of Montrose,
COUNTY OF FORFAR.
PARTIAL DEMOLITION AND RECONSTRUCTION OF BRIDGE OVER THE SOUTH ESK.
Montrose Bridge Joint Committee are prepared to receive TENDERS for the PARTIAL DEMOLITION and RECONSTRUCTION in REINFORCED CONCRETE of the MONTROSE BRIDGE over the South Esk, together with the PROVISION of a TEMPORARY BRIDGE.
The existing suspension bridge is to be demolished and replaced by a reinforced concrete cantilever bridge, central span 216ft. and two side spans of 106ft. with cylinder foundations in river.
Drawings and specifications, &c., may be seen on and after Wednesday, 7th March, 1928, at the offices of Burgh Surveyor, Town Hall, Montrose ;
The Ministry of Transport, 122, George-street, Edinburgh ;
Sir E. Owen Williams, K.B.E., 5, St. George's-road, Westminster, London, S.W. 1.
Documents, including bill of quantities and drawings, may be obtained on and after the same date at the office of the Engineer, Sir E. Owen Williams, K.B.E., 5, St. George's-road, Westminster, S.W. 1, on depositing £5 5s. and undertaking to return all documents and drawings. The deposit will be returned on receipt of a bona fide Tender. Cheques should be made payable to Montrose Bridge Joint Committee.
Sealed Tenders, endorsed "Tender, Montrose Bridge," must be lodged with the undersigned not later than Thursday, 29th March, 1928. The Committee do not bind themselves to accept the lowest or any Tender.
JAMES CUMMING,
Clerk to the Committee.
Town Clerk's Office,
Montrose, Forfarshire,
27th February, 1928. 7859

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PUBLIC NOTICES

Stanley Urban District Council.

CAST IRON AND STEEL WATER PIPES, &c.

TENDERS are INVITED for the SUPPLY of the following :—

CONTRACT No. 1 : CAST IRON PIPES.
About 4100 lin. yds. 12in. internal diameter Cast Iron Pipes.
About 700 lin. yds. 6in. internal diameter Cast Iron Pipes.
About 100 lin. yds. 4in. internal diameter Cast Iron Pipes.
About 10 tons of Cast Iron Special Pipes.
NOTE.—In the case of the 6in. and 12in. Cast Iron Pipes, prices may be submitted for same lined with Bitumen or Concrete or twice coated. Separate forms should be used if more than one of the alternatives is to be quoted for.

CONTRACT No. 2 : STEEL PIPES.
About 42 lin. yds. 12in. internal diameter Flanged Steel Pipes, lined with Bitumen or Concrete.

CONTRACT No. 3 : VALVES.
13 No. Sluice Valves, 3in. to 12in. diameter.
18 No. Valve Hydrants.
6 No. Air Valves.

CONTRACT No. 4 : CAST IRON COVERS.
37 No. Various Cast Iron Surface Boxes.

Form of Tender, &c., may be obtained on application to Mr. C. Clemesha Smith, M. Inst. C.E., Town Hall, Wakefield.

Each application must be accompanied by One Guinea, which will be returned on receipt of a bona fide Tender.

Sealed Tenders are to be delivered to the undersigned on or before the 31st March, 1928, marked "Water Tender."

The Council do not bind themselves to accept the lowest or any Tender.

E. H. MIDDLEBROOK,
Clerk to the Council.

Pearl Chambers,
East Parade, Leeds. 7957

TO DREDGING CONTRACTORS.
HARBOUR OF WATERFORD.

Waterford Harbour Commissioners.

The Waterford Harbour Commissioners are prepared to receive TENDERS for DEEPENING the BERTH known as the "Grain Berth" and situate on the north side of the River Suir at Waterford.

The area to be deepened is approximately 450ft. long by 75ft. wide, having a surface level of about 22ft. below Low Water Ordinary Spring Tides and is to be deepened to 25ft. below L.W.O.S.T.

The material to be removed is rock.

Copies of the plan, specification and conditions can be obtained on application to the Harbour Engineer, Harbour Office, Waterford, on payment of Five Guineas, which will be returned in case a bona fide Tender is duly made.

Tenders must be addressed to "The Chairman, Waterford Harbour Commissioners, Harbour Office, Waterford," in a sealed cover endorsed "Grain Berth Tender," and must be delivered not later than One o'clock p.m. on Monday, the 19th day of March, 1928.

The lowest or any Tender will not necessarily be accepted.

Dated the 28th day of February, 1928.

AUSTIN A. FARRELL,
Secretary to the Waterford Harbour Commissioners.
Harbour Office, Waterford. 7880

Southport, Birkdale and West

LANCASHIRE WATER BOARD.
APPOINTMENT OF ASSISTANT ENGINEER.

The Water Board invite APPLICATIONS for the APPOINTMENT of ASSISTANT ENGINEER at a salary of £400 per annum.

Applicants should be between the ages of 28 and 35 years and Associate Members of the Institution of Civil Engineers. They should have had experience of the design and construction of Waterworks (preferably pumping schemes) and general administration of waterworks undertakings. They must also be capable surveyors and good draughtsmen.

The appointment will be made subject to the provisions of the Local Government and other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination.

Applications, in candidates' handwriting, stating age, whether married, qualifications, training, details of experience, present and past appointments, and accompanied by copies of three recent testimonials, must be delivered to the undersigned on or before Monday, 19th March, 1928, endorsed "Assistant Engineer."

Canvassing, either directly or indirectly, will be a disqualification.

C. BURTON EDE, M. Inst. C.E.,
Engineer and Manager.

14, Portland-street, Southport,
25th February, 1928. 7871

The Following Vacancies Occur

in the DRAWING-OFFICE of the Hull Corporation Electricity Department, viz.:—

3 CONSTRUCTIONAL DRAUGHTSMEN.
2 (TEMPORARY) MAINS SURVEY DRAUGHTSMEN (approximate period of 2 years).

Ages 21-25 years.

Salary as per scale (£127 to Grade 9A, N.J.B. Schedule of Salaries, subject to cost-of-living variations and to deductions in accordance with the L.G. and other Officers' Superannuation Act).

Applicants must be of smart appearance and pass the prescribed medical examination.

CONSTRUCTIONAL DRAUGHTSMEN.—Preference given to those with experience in Building Construction, Constructional Steel Work and Plant Lay-out.

MAINS SURVEY DRAUGHTSMEN.—Must be neat and quick at Tracing and Lettering and be able to use Theodolite and Dumpy Level. Small specimen of tracing and lettering to be forwarded with application.

Forms of application may be obtained from the CITY ELECTRICAL ENGINEER, Sculcoates-lane, Hull, and should be completed and returned, endorsed "Constructional Draughtsman" and Mains Surveyor" respectively, by not later than March 16th, 1928. 7965

The South Indian Railway

COMPANY, LIMITED.

APPLICATIONS are INVITED from duly qualified candidates for the APPOINTMENT of ASSISTANT SIGNAL and TELEGRAPH ENGINEER on the Company's staff in India.

Candidates, who should preferably be not less than 25 years of age and unmarried, must have received a sound general education and the technical training in Electrical subjects required for Associate Membership of the Institution of Electrical Engineers.

They must further have served an apprenticeship in the Signal or Telegraph Department of an English Railway or with a firm specialising in the manufacture of signalling apparatus, and have a thorough working knowledge of British Railway Signalling practice, including automatic signalling and track circuits and the preparation of locking tables.

The salary of the appointment, which in the first instance will be for three years under agreement, will commence at Rupees 450 per mensem (inclusive of Rupees 150 Overseas Pay), rising by annual increments of Rupees 50 per mensem to Rupees 550 per mensem, inclusive, for the third year, and in the event of extended service to a maximum of Rupees 800 per mensem, inclusive.

A first class passage to India will be provided by the Company, as also, subject to the terms of the agreement, a free passage home in the event of the termination of the service at or before the end of three years. If the employment is extended beyond five years, the employee will become eligible for certain free passage concessions for himself and family.

The salary will commence on the date of embarkation to India.

The successful candidate will be entitled to the benefits of the Railway Provident Institution.

Forms upon which application must be made may be obtained on written application to Messrs. ROBERT WHITE and PARTNERS, 3, Victoria-street, London, S.W. 1, the Consulting Engineers to the Company. 7971

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ASSISTANT to MANAGING DIRECTOR WANTED for General Engineering Works (1000 hands). Capacity on commercial side of first importance. Age 35-45.—State fully, in confidence, particulars of business experience, age, where educated and salary required.—Write, "ACTION," c/o Street's, 6, Gracechurch-street, E.C. 3. 7960 A

FIRST-CLASS STRUCTURAL STEEL WORK DESIGNER REQUIRED. Must be used to requirements of L.C.C. Regulations with respect to Steel-framed Buildings and Theatres of all descriptions.—Apply by letter only, stating age, experience, and salary required, to SECRETARY, Moreland, Hayne and Co., Ltd., 80, Goswell-road, E.C. 1. P4253 A

GOOD COMMISSION OFFERED MAN Who Can place Reliable Case-hardening Compound.—Address, 7910, The Engineer Office. 7910 A

LONDON SALES MANAGER WANTED, with Good business experience. Sound knowledge of Workshop Equipment essential. Directorship available good type man. Investment.—Write, Box 882, Sells, Fleet-street, E.C. 4. 7894 A

OIL-BURNING EQUIPMENT SPECIALISTS REQUIRE ENGINEER with commercial experience for Sales Co-operation Staff. Commencing salary £300.—Address, 7923, The Engineer Office. 7923 A

POSITION of SENIOR SALESMAN in London Office of important Continental Electrical Plant Engineers requires to be filled. Only candidates with thorough technical knowledge and proof of capacity to sell on quality rather than price are invited to send full particulars with photo.
Address, P4246, The Engineer Office P4246 A

REFRIGERATING ENGINEER, Thoroughly Conversant with estimating and tendering, REQUIRED by London Firm of Refrigerating Engineers. Permanent position offered if suitable. Stats age and salary required.—Address, 7941, The Engineer Office. 7941 A

REINFORCED CONCRETE DESIGNER WANTED QUICKLY, experienced in preparation of calculations and working drawings.—Write, stating experience, age, and salary required, to INDUSTRIAL CONSTRUCTIONS, Ltd., 44, Grosvenor-place, London, S.W. 7947 A

REINFORCED CONCRETE DESIGNER REQUIRED, with sound knowledge of theory and previous experience with specialist firm.—Address, stating full particulars of experience and salary required, 7933, The Engineer Office. 7933 A

REQUIRED, a SALESMAN Having a Technical knowledge of Air Heating and Drying, and a connection amongst users of such plant.—Address, 7928, The Engineer Office. 7928 A

SALES ENGINEER REQUIRED, Resident in Birmingham or District, to REPRESENT well-known Centrifugal Oil Purifier Manufacturers. Must have good Engineering and Sales experience. Remuneration by salary and commission. State age, experience, salary required, and if possessing own car.—Write, Box 117, c/o Mather and Crowther, Ltd., 10/13, New Bridge-street, E.C. 4. 7972 A

WORKS MANAGER for Bridge and Constructional Steel Works. Applicant must have held successfully a similar post, be able to make up estimates and have a thorough knowledge of piecework rates.
Address, stating age, experience, and salary, 7908, The Engineer Office. 7908 A

WANTED, DRAUGHTSMAN for Estimating Department of North-East Coast Marine Engineering Works, able to get out machinery arrangements and estimates.—Address, stating age, experience, qualifications, and salary required, 7929, The Engineer Office. 7929 A

WANTED, TWO SENIOR DRAUGHTSMEN, with experience in Modern Cement Works and Construction of River Jetties. State age, experience, and salary required.—Address, 7915, The Engineer Office. 7915 A

DRAUGHTSMAN REQUIRED by Engineering Firm in West of England. Must have good knowledge of Pneumatic Conveying and Elevating Plants. State age, experience, and salary required.—Address, 7884, The Engineer Office. 7884 A

DRAUGHTSMAN REQUIRED by Engineering Firm in West of England, with first-class experience in the lay-out of schemes and getting out designs and quantities for estimating. Must have a thorough knowledge of Labour-saving Appliances for the handling of materials, such as Elevators and Conveyors and Machinery required for Docks, Power Stations, and Works Equipment. Originality and initiative essential.—Address, 7885, The Engineer Office. 7885 A

DRAUGHTSMAN REQUIRED by London Constructional Engineers for Detailing Structural Steel Work. Some knowledge of L.C.C. Regulations. Permanency to suitable men.—Address, giving particulars of age, salary, &c., 7963, The Engineer Office. 7963 A

DRAUGHTSMAN REQUIRED for Machine Tool Work of latest design. Preference only given to man with such experience.—Address, stating age and salary required, 7946, The Engineer Office. 7946 A

DRAUGHTSMAN (SENIOR) REQUIRED, Experienced in latest practice of large D.C. Electrical Machinery.
THE LANCASHIRE DYNAMO AND MOTOR CO., Ltd., Trafford Park, Manchester. 7951 A

DRAUGHTSMEN.—WANTED, Thoroughly Experienced and capable SENIOR DRAUGHTSMEN for General Engineering Works.—Apply, stating age, experience, and salary required, to FRASER and CHALMERS, Erith, Kent. 7968 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine Design and Detail Work, for works in Midlands. State age, salary, experience, and when able to commence.—Address, 7930, The Engineer Office. 7930 A

ENGINEER-DRAUGHTSMAN (JUNIOR) REQUIRED for general drawing-office work in connection with an Electricity Supply Undertaking. Applicants should preferably have had Mechanical and/or Electrical Engineering training.
Apply, giving full particulars of experience and salary expected, to C. M. SHAW, M.I.E.E., City Electrical Engineer, Worcester. 7850 A

EXPERIENCED DRAUGHTSMAN REQUIRED for Temporary Position, accustomed to the designing of Girder Work and other Constructional Work, measuring up existing bridges, calculation of stresses, &c.
Apply by letter to W. E. THORNHILL, Divisional Engineer's Office, L.M.S. Railway, Crewe, stating age, experience, and salary required. 7948 A

FIRST-CLASS DRAUGHTSMEN REQUIRED for Works in London, with General Engineering experience.—Address, stating age, experience, and salary required, 7938, The Engineer Office. 7938 A

MECHANICAL HANDLING PLANTS.—ESTIMATING DRAUGHTSMAN REQUIRED, having sound technical training and all-round experience in the above for old-established firm in the Midlands. Capable of making own calculations and working quickly with minimum supervision. Only experienced men with the necessary qualifications need apply. State age, experience, and salary expected.—Address, 7920, The Engineer Office. 7920 A

SITUATIONS OPEN (continued)

MACHINE TOOL DRAUGHTSMAN, Preferably having held responsible position and experienced in Large Machine Tools (Horizontal Boring Machines, Wall Planers, Specials, &c.). Permanency for competent designer.—Address, stating terms, experience, &c., in confidence, P4267, The Engineer Office. P4267 A

SENIOR MECHANICAL DRAUGHTSMAN REQUIRED. Experienced in modern Power Station practice. State age, experience, and salary required.—Apply, CHIEF DRAUGHTSMAN, International Combustion, Ltd., Africa House, Kingsway, W.C. 2. 7931 A

SEVERAL Competent DRAUGHTSMEN REQUIRED IMMEDIATELY, with Boiler-house experience, preferably furnace work.—Apply by letter, stating age and salary required, to COMBUSTION ENGINEERING, Ltd., Derby. 7943 A

SUPERIOR DRAUGHTSMAN REQUIRED, Preferably with some experience in Steel Structures, for London area.—Address, stating age, experience, and salary required, 7939, The Engineer Office. 7939 A

SYNTHETIC AMMONIA and NITRATES, Ltd. (associated with Imperial Chemical Industries, Ltd.), REQUIRE the SERVICES of SEVERAL DRAUGHTSMEN for each of the following classes of work :—
(1) General Architectural Draughtsmen used to planning, detailing quantities and specifications.
(2) Railway Draughtsmen used to lay-out and details of permanent way.
(3) Surveyors' Draughtsmen used to plotting surveys and the preparation of finished plans.
Applicants must possess first-class experience of the class of work in which application is made, and the salary offered will be between £250 and £400 per annum, according to qualifications.
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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The Empire Airships.

IT would be satisfactory if we could be given a clear official statement regarding the two 5,000,000 cubic foot airships now under construction in this country and what is to be done with them when they are finished. A fair amount of information has recently been made available concerning the progress towards completion of the R 100, the Airship Guarantee Company's vessel, but corresponding particulars regarding the Government vessel, the R 101, are still being withheld. Nevertheless, Sir Sefton Brancker, who, as Director of Civil Aviation, ought to be in a position to speak with authority on the subject, remarked at a meeting of the Institute of Transport on Monday night, March 5th, that there was every probability that both airships will be flying this year. From that remark we deduce that the progress being made with the Guarantee Company's ship is rapid and that the construction of the Government vessel is much further advanced than we had any reason to believe. Again, some definite information might now be given of the Government's plans for the running of the airships. It was indicated some time ago that the Guarantee Company would exercise its option to purchase its vessel, the R 100, when its contract with the Government to build it was completed, and subsequently it was given out that the Guarantee Company was actively contemplating the institution of a regular Transatlantic airship service. According to Sir Sefton Brancker, the first regular route would probably be to Canada *vid* the Azores on the outward trip, and that a service might be organised to Egypt. Neither service could be maintained with one airship. It would therefore appear that one or other of these services is to be operated by means of two airships working in conjunction with each other, one owned and controlled by the Government and the other owned and controlled by a private company. The arrangement does not seem the best that could be designed.

The Lochaber Hydro-Electric Scheme.

ON Saturday of last week, March 3rd, an important stage was reached in the construction of the Lochaber hydro-electric undertaking. An outline of this scheme as submitted to Parliament was published in our issue of March 4th, 1921. Work upon it was begun in 1924. One of its main features is a pressure tunnel about 15 miles long, whereby the waters of Loch Treig, raised by other works to 40ft. above their natural level, will be taken to the power-house situated at Fort William. This tunnel is of particular interest because, according to the original plans, it is to draw off from Loch Treig at a depth of 139ft. below its raised surface level. About 10 miles of the tunnel have now been driven as a result of last Saturday's work, which involved blasting away the last portions of rock separating the two sections in which the driving operations were conducted. The two portions, we understand, met with less than 1in. of deviation. The contractors for the work are Balfour, Beatty and Co., Ltd. The complete scheme will involve an expenditure of about £6,000,000 and is being carried out for the Lochaber Water Power Company, an offshoot of the British Aluminium Company which will be the chief user of the power made available.

The Faraday Lecture.

ON Thursday of last week, March 1st, Dr. Ferranti delivered the Faraday Lecture at the London headquarters of the Institution of Electrical Engineers, and took as his subject "Electricity in the Service of Man." The uses of electricity were divided into two sections, which the lecturer classed as competitive and non-competitive, because for some purposes, such as telegraphy and telephony, electricity has no competitor, whilst for others it has to compete with such things as steam and gas. Although Dr. Ferranti did not tell those present anything they did not already know, he reviewed the advances made in electrical matters in an interesting manner, and the lecture was well received. Attention was drawn to the fact that one of the great drawbacks to electricity is the lack of a good storage system, and if something very much better than that existing could be devised, electric motors would, to a very large extent, replace small internal-combustion engines. Electric motors might, in fact, even be employed for driving aeroplanes. The motor car with all its modern electrical equipment and the introduction of wireless telephony had, said the lecturer, done a great deal to arouse interest in electricity, and it was remarkable how many people were now able to follow wiring diagrams and make up successful wireless sets. The lecture has been delivered at five of the Institution's centres as well as in London, and is to be given at three more centres. Referring to his visits to the various centres, Dr. Ferranti said that, bearing in mind the remarkable joint meeting at which, by means of wireless telephony, members of the Institution of Electrical Engineers and the American Institute of Electrical Engineers were able to take part, he wondered if in future the Faraday Lecture delivered in London would also be heard at the provincial centres simultaneously. From one point of view he would have liked to have spoken for one evening only and have conveyed all he had to say to the members in different parts of the country, but, on the other hand, he would have missed the great pleasure of meeting many old friends. Moreover, he would not have discovered in the manner he had done how much the subject of electrical development appealed to the Institution as a whole.

The Shannon Power Scheme.

A REPORT issued by the Irish Free State Electricity Board outlines the plans for the distribution of current from the power station at Ardnacrusha. In the first place a supply will be given to Dublin, where the existing network will be used. The municipal undertaking will connect its transforming station with that which is being built by the Shannon Electricity Board, and the work of switching over to the new source of supply will present no difficulty. Cork and Limerick will be dealt with as soon as possible. In the opinion of the Board the interests of the country will best be served by the acquisition of all existing undertakings by the State, and negotiations are in progress for the taking over of the undertakings in Dundalk, Wexford and Clonmel. The Board has also mapped out an ambitious programme for the electrification of some 130 towns and villages where electricity is not at present available. Householders are to be assisted to wire their houses on the instalment system, and a national census is being taken of all the electricians and electrician's apprentices in the Free State in order that the problem of obtaining skilled labour may be solved with a minimum amount of delay. It is expected that the electrification of the Free State will be in full swing by the middle of next year, and in order to ensure success for the scheme the Board is preparing an extensive publicity campaign which will bring the benefits of electricity in the home and on the farm before the notice of the people.

The Exhaust Turbine Drive for Large Liners.

INTEREST attaches to the recent proposal put before the United States Shipping Board to equip the ex-German liners "George Washington," "Mount Vernon," and "Monticello" (formerly the "Agamemnon") with exhaust turbine drives of the Bauer Wach type. In the case of the two last-named liners, which have been laid up for some time, it was proposed to set apart about £2,500,000 for the reconditioning of the hulls and the fitting of new propelling machinery of the geared turbine type, such as was recently installed in the 17,000-ton Matson liner "Malolo." If the proposal above referred to be accepted, the work on the engines can be done for, it is stated, a little over £100,000. It is suggested that exhaust turbines should be fitted to each of the two after engines, which, without increasing the amount of fuel consumed, would give 3000 S.H.P. extra on each shaft so fitted, raising the total output to 26,000 S.H.P. This power would give the ships a speed of 20 knots, although the service speed fixed for Atlantic passages would be about 18 knots. The suggestion is à propos, inasmuch as the main reciprocating engines with which the ships are equipped were designed by Dr. Bauer, who, with Dr. Wach, has developed the exhaust turbine system, which in Great Britain is being dealt with by William Beardmore and Co., Ltd., and Swan, Hunter and Wigham Richardson, Ltd. Already some important conversions are in hand, and the advantages of the exhaust turbine drive are being carefully considered by some of the larger companies, who own large ships propelled by steam reciprocating engines.

A Diesel Electric Oil Tanker.

THE oil tanker "Brunswick," which was launched from the yard of Scott's Shipbuilding and Engineering Company, Ltd., Greenock, on Wednesday, March 7th, is the first vessel of its type to be built in Great Britain and the largest to be fitted with Diesel-electric propelling machinery. The "Brunswick" is being constructed to the order of the Atlantic Refining Company, of Philadelphia, which firm already owns eight electrically propelled tankers and tugs. The new tanker has a length of 469ft., with a beam of 63ft. and a depth of 36ft. 9in. She has a gross tonnage of about 9000, and will be fitted out to carry 12,500 tons of petroleum spirit on a light draught. The hull is built on the longitudinal system of framing, and the single-screw machinery is installed aft. There are four generator units, each of which comprises a Carels-Ingersoll-Rand four-cycle six-cylinder airless injection engine, coupled direct to one main and one auxiliary generator. The engines have a bore of 19¼in., with a stroke of 24in., and are each designed for a normal output of 750 B.H.P. at 225 r.p.m. The main generators each have a designed output of 600 kW at 250 volts, and are arranged to work in series so that current at 1000 volts is supplied to the double-armature motor on the propeller shaft. This motor is designed to transmit 2800 S.H.P. at 95 r.p.m., and between the motor and the propeller shaft there is fitted a thrust block of the Michell type. The switchgear is mounted on a central switchboard, and the controls are arranged on the bridge so that the navigation of the ship is entirely in the hands of the deck officers. The engines are being supplied by Carels Works at Ghent, and the generators, motors and control gear by the British Thomson-Houston Company, Ltd., of Rugby. Most of the deck, engine-room and cargo auxiliaries are electrically driven, and heating for the accommodation is provided by a small exhaust gas boiler, which can also be independently fired. The machinery has been designed to the requirements of Mr. Lester Goldsmith, the owner's consulting engineer, and to Lloyd's classification survey.

Workman, Clark and Co., Ltd.

IT is announced that Mr. William Strachan, a former director and secretary of Workman, Clark and Co., Ltd., of Belfast, in association with a group having, it has been stated, mainly Scottish interests, has purchased from the joint receivers acting on behalf of the Prior Lien Debenture holders, the shipyard works and business of the Belfast firm, which includes a share interest in the Cyclops Foundry and Patternmaking Company, Ltd., of Glasgow. Mr. Strachan is a native of Glasgow, and before taking up an appointment with the Belfast company in 1901 was with the Glasgow shipowning firm of William Robertson. When the ownership of Workman, Clark and Co., Ltd., was changed in 1920, Mr. Strachan continued as the secretary of the company, and eventually he became a director. The yards were closed down at the end of January last, after the completion of the motor passenger liner "Bermuda," and the motor oil tanker "Chesapeake," but the plant has been carefully kept in order, and is ready, we understand, to begin work as soon as material comes to hand. It is hoped that orders for two vessels will be placed almost immediately, and that the keels will shortly be laid, enabling work to be resumed at the yard at an early date. We understand that the business will be carried on by the new owners under the old name.

The Skidding of Motor Vehicles.

THE Ministry of Transport has issued a statement concerning its investigations into the causes of and means for preventing the skidding of motor vehicles. Modern hard, smooth, impervious road surfaces become polished under the wear of rubber tires, and in the presence of oil and moisture offer little resistance to skidding. Much has been done to reduce the trouble by applying to the surface a heated liquid dressing incorporating sharp crushed gravel or granite chippings. The fundamental causes of skidding have not, however, yet been elucidated. Much yet remains to be done to determine the part played by the nature of the roads on the one hand, and the part played by the vehicles themselves on the other. These two aspects of the subject are now being investigated by the Ministry. The behaviour of the arterial roads in London is being closely watched, and the results yielded by the large numbers of surfacing materials employed are being studied. On the Barnet by-pass and the East Ham and Barking by-pass roads experimental sections have been laid, either with proprietary materials or with concrete laid in a variety of ways. A small portable machine, designed and made at the National Physical Laboratory, is being used to measure the coefficient of friction between rubber tires and the common types of road surface in the London area. On the other side of the question attention is being paid to the possibility of modifying the design of road vehicles in the direction of lessening the demand for resistance from the roads and tires to restrain them from skidding. To that end a special model vehicle has been constructed with which experiments are to be carried out.

Thames Floods.

THE report of the committee appointed at a conference of public authorities to consider the question of floods from the river Thames within the County of London contains much interesting information, but so far as steps intended to prevent a recurrence of the disastrous flood of January 6th and 7th, 1928, are concerned, it is confined to the suggestion that the whole subject of tides in the Thames requires further expert investigation, and to the recommendation that that investigation should be undertaken by the Liverpool Tidal Institute. The committee considers that the London County Council should have the statutory duty imposed on it of supervising and inspecting flood defence works, and that a scheme for giving warning of the approach of an abnormally high tide should be instituted. The report is interesting in that it shows that the flood of January 6th and 7th was not only 4ft. 8in. to 5ft. 10in. above the predicted levels of the tide at different points on the river, but that high water occurred at from 7 to 30 minutes sooner than predicted. Another interesting minor feature recorded in the report is that the yearly average of all high waters since 1890 shows a well marked and steady increase, totalling 1ft. at the Hammersmith gauging station and a less marked increase totalling 0·6ft. at the Chelsea station. Lower down the river there is no definite sign of an increase. In fact, at North Woolwich there are signs of a decrease amounting to about 0·4ft. in all over the thirty-eight years.

The Röttle Hydro-Electric Power Station.

No. I.

THE power station at Röttle, on Lake Vetter, the best-known town near which is, perhaps, Jönköping, where Swedish matches are largely made, is of interest on account of the manner in which the constructional problems which were met with have been handled. The Röttle Power Station has been designed to utilise the water flowing from Lakes Oren, Bunn and Upper and Lower Kvarnsjön, as shown on the map, Fig. 1. Lake Bunn embraces the chain of lakes running North and South in the centre of the map. Upper and Lower Kvarnsjön are marked A and B respectively, and it is through them that the discharge from the whole of the catchment area passes.

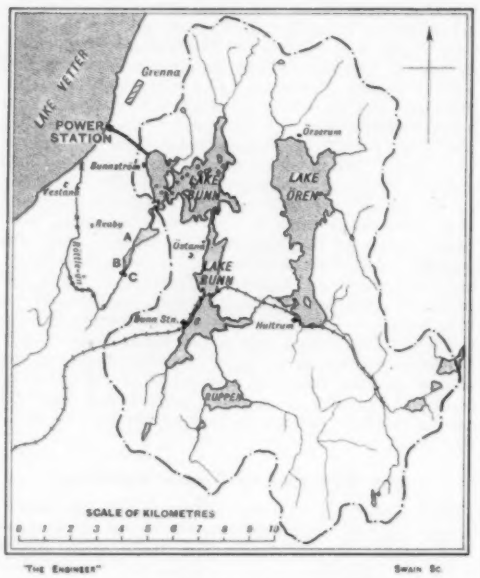


FIG. 1—LAKES VETTER, OREN, BUNN, ETC.

The watershed is indicated by the encircling line. The catchment area is about 194 square kilometres in extent, and of that total about 19·7 square kilometres, or about 10 per cent., is represented by lake surfaces. The average run-off in this area amounts to about 7 litres per second per square kilometre, which gives an average total flow of nearly 1·4 cubic metres per second, while the volume at times of normal low flow is estimated to fall to 0·5 cubic metres per second. The lakes are so regulated that the average amount of water can be so used as to coincide with the year's load curve. With a future increase in the head resulting from increased regulation, in conjunction with streams not at present regulated, concentrated into a single period of low water, a still further amount of power can be obtained.

The regulation conditions were based on the natural levels of Lake Bunn, as follows:—Exceptional high water level, 196·8–196·9; exceptional low water level, 195·6; normal high water level, 196·7; normal low water level, 196–196·10; these figures being in metres above sea level. In Lake Oren these levels are about 0·2 m. higher, and in Lower Kvarnsjön about 0·3 m. lower. The height at which the regulation of the water level is fixed by the County Authorities lies between 196·7 and 195·7. It will thus be seen that the highest and lowest water levels vary only very slightly.

The storage reservoir will ordinarily only be drawn upon to a greater or less extent in the latter part of summer, and, in certain years, in the beginning of autumn. At other times the normal run-off from the catchment area will, it is anticipated, furnish the full volume of water required at the power-house. The reservoir is filled during the rainy months of autumn and winter, and during the later spring floods, which are caused by the thawing of snow and ice and the release of water from the frozen surfaces of the earth. Drawing down to the lowest limit of regulation should only occur in years when the period of summer low water is followed by shortage of rainfall in the autumn season. The summer water level, therefore, keeps within the above-mentioned limits of regulation, or about 0·3 m. over the natural levels, and the damage which that rise in level causes mainly affects arable land, the damage to woods and pasture land not being of much importance. Any damage that there is—and it is unimportant under the circumstances compared with the benefit resulting from regulation—was met by way of compensation to the landowners at the time of construction of the plant.

The complete works necessary in connection with regulation include the construction of a dam below Lower Kvarnsjön, and of a canal with a total fall of about 2 m. between Lakes Oren and Bunn, with certain minor dredging operations under the arches of the railway bridge over the Bunn and between the Upper and Lower Kvarnsjön and Bunn.

The regulating dam which has been built at the point C—Fig. 1—at the outlet of the Lower Lake Kvarnsjön, is constructed of concrete, and provided with a spillway for exceptionally high water and for the passing of compensation water for domestic purposes down the river bed. Its design is shown in Fig. 2. Its crest is at El. 197·5, and the gate sills at + 194·7. The openings for discharging the flood are four in number, each with 0·9 m. free width and 1·7 m. head above the sills at the highest water level in the lakes. The area of the openings below the upper storage limit is a little larger than the free area

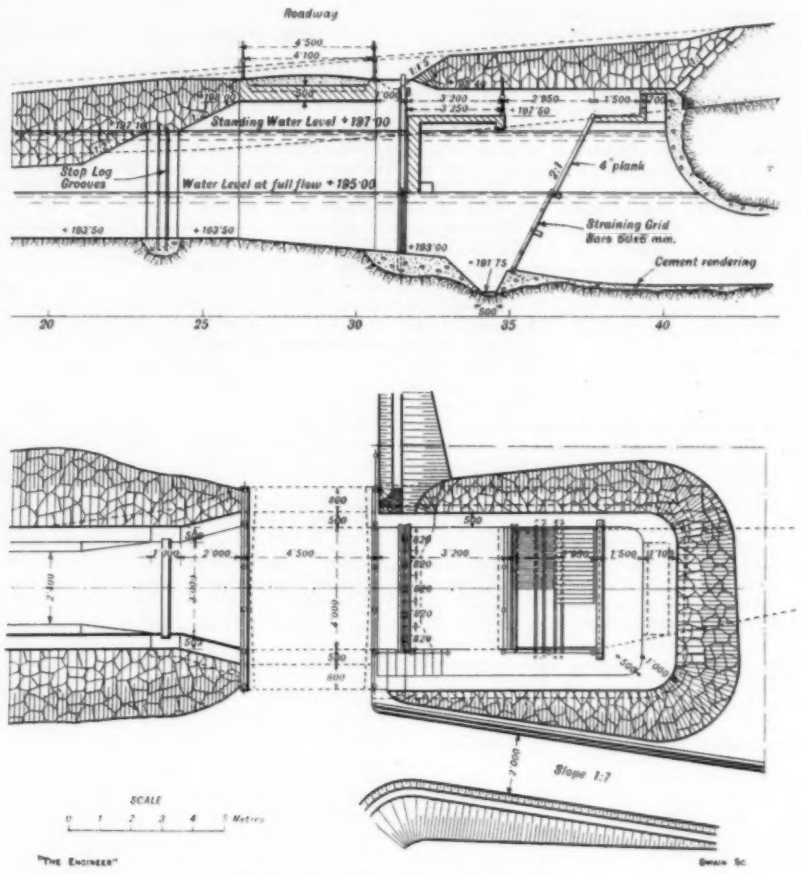


FIG. 3—INTAKE WORKS ON LAKE BUNN

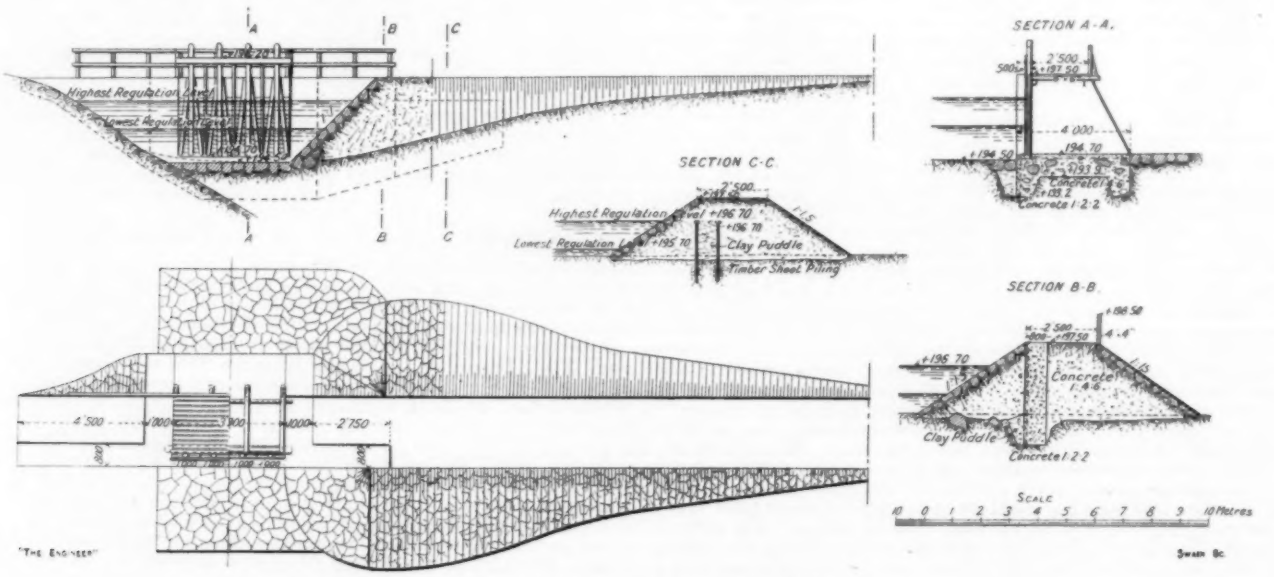


FIG. 2—LAKE LEVEL REGULATING ARRANGEMENTS

of the natural river at the previous high water level. The gates are made of 3in. wooden boards with tongues and grooves and provided with liners of rolled steel angles in order to decrease the frictional resistance at the hoisting. The body of the dam is made of concrete with back-filling of well-tamped earth against the abutments.

The canal between Lakes Oren and Bunn, the construction of which has been postponed till the necessity arises, is calculated to pass, when the storage basin is empty, 0·6 cubic metres per second, which

represents that part of the regulated draw-off that corresponds to the catchment area of Oren. The various interests, such as fishing and boat traffic on Lake Oren, and domestic supply, have been suitably provided for.

The large development rendered possible by the regulation works has been based on the combined public utility load and an eight hours' industrial day. The power-house has been arranged to utilise a maximum quantity of water for power purposes of about 5 cubic metres per second. With normal mean water level in Lake Vetter at + 88·7, the gross head available, within the limits of regulation referred to above, amounts to from 107 m. to 108 m. At the power-house after allowing for friction losses in the pipe line, which are reckoned at 6 m., the head available on the turbines varies from 101 m. to 102 m. at full load. The power derivable from this head with the constructional work as built, and with the maximum of three units installed, is estimated at 4000 kW on the turbine shafts.

For the development of the power the main works consist of (*a*) an intake on Lake Bunn; (*b*) a tunnel through the Grennaberg; (*c*) the pressure pipe line; (*d*) the power station; and (*e*) the outlet into Lake Vetter. The intake, which is situated at the N.W. corner of Lake Bunn, consists of a short canal which is crossed by a road bridge and is furnished with inlet sluice arrangements and a strainer—see Fig. 3. The

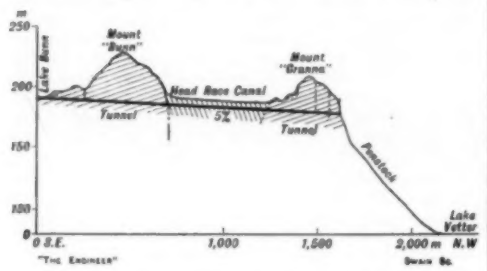


FIG. 4—DIAGRAMMATIC SECTION OF AQUEDUCT

canal, before it enters the tunnel, runs partly through sand, partly through rock. The intake sluice arrangement for controlling the flow into the canal is placed immediately downstream of the bridge carrying the roadway. Upstream of the bridge there are stop log grooves so that the intake may be closed for inspection purposes. Between Lake Bunn and the stop log grooves the canal is level throughout and has a bottom width of 2·4 m. The sides of the canal in rock are battered 10 vertical to 1 horizontal, whereas the sides of the canal in earth have a slope of 1 : 1 and are provided with stone pitching.

The highway bridge is made of reinforced concrete and is separated from the sluice structure by an expansion joint. To obtain water-tightness the joint is provided with an asphalt coating on a 10 cm. thick layer of rich concrete mixture 1 : 2 : 2. The control arrangement consists of simple hand-operated wooden gates. Below the gates there is placed an ice screen made up of 60 mm. by 6 mm. flat steel bars with rounded edges. To ensure a smooth flow between the sluice structure and the tunnel the inlet section of the tunnel is formed as shown in the illustration. All slopes in earth are covered with stone pitching, and drainage is provided all around the sluice structure and the highway bridge.

The aqueduct, of which a diagrammatic sectional sketch is given in Fig. 4, has a total length of about 1·5 kiloms. and consists, first of all, of a tunnel 943 m. long, then an open canal 206 m. long, which is followed by another tunnel 422 m. long. The first tunnel discharges into a valley, through which the water flows for the most part in open canal, and the lower end of which is shut off to the S.S.W. by an earth dam so as to form a small basin. From the basin the water is conducted through the second tunnel to the foot of the mountain east of the road from Grenna to Jönköping. The canal between the two tunnels has a bottom width of 2·0 m. and sides sloping 1 : 1, covered with stone pitching. Where the canal runs through rock the sides are battered 10 : 1.

The dam just referred to is made of earth and stone filling, and it has a waterproofing reinforced concrete core wall in the centre—see Fig. 6—which is carried down to and connected by means of a cut-off with sound rock. The top level of the core wall is at El. 197·30. In the angle at the connection between the core wall and the rock three layers of tarred jute cloth are arranged on the water side, and they are cemented to the concrete by means of hot asphalt for a width of 5 cm. from the edge. The crest of the dam is at El. 198·00 and it has a width of 4·0 m. The side faces are given slopes of 1 : 2. A country road, which previously crossed the basin, has been relocated so as to run over the dam.

The connection between the canal and the second tunnel is, like the canal from Lake Bunn to the first tunnel, provided with a strainer of 60 mm. by 6 mm. flat bars with rounded edges. In case the strainers should become clogged both are furnished with an air blast arrangement for clearing them. In order to obtain a smooth flow between the open canal and the tunnel the intake of No. 2 tunnel has been formed much in the same way as that for tunnel No. 1. The tunnels, which have a cross-sectional area of 4·8 square metres, have the shape shown in Fig. 7, which also gives a longitudinal section of the upper tunnel.

For speeding up the work the tunnels were driven from the portals and from construction shafts simultaneously. The shafts were placed at such a distance that the distances between each point of attack did not exceed 230 m. in length. The rock excavation amounted to about 7500 cubic metres for the tunnels and for a surge tank. Power for the working operations was taken from a temporary power station of 325 kW capacity constructed on the Röttle River.

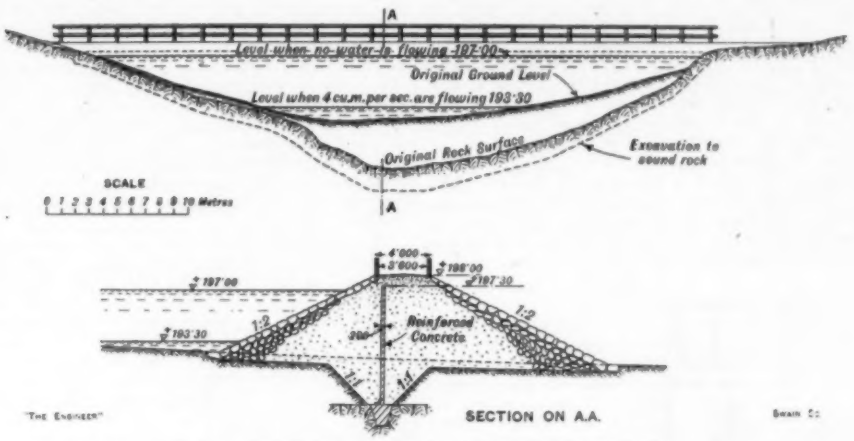


FIG. 6—RETAINING DAM IN VALLEY BETWEEN TUNNELS

The surge tank—Fig. 8—which is formed just at the top of the pressure pipe line, is designed to receive a volume of about 560 cubic metres of water—or rather over 120,000 gallons—at any possible water level. The tunnel can be shut off by means of a 2·7 m. butterfly valve placed at the upstream side of the surge tank. This arrangement has the advantage of securing air supply to the pipe line, even if the valve should be closed. The valve is mounted on a short mouthpiece of steel plating, which is concreted in at the end of the tunnel next to the surge tank. Round the valve the rock is excavated to provide space for fixing the valve to the mouthpiece. The transition from the surge tank to the tunnel is rounded and concreted in order to reduce the loss of head as much as possible.

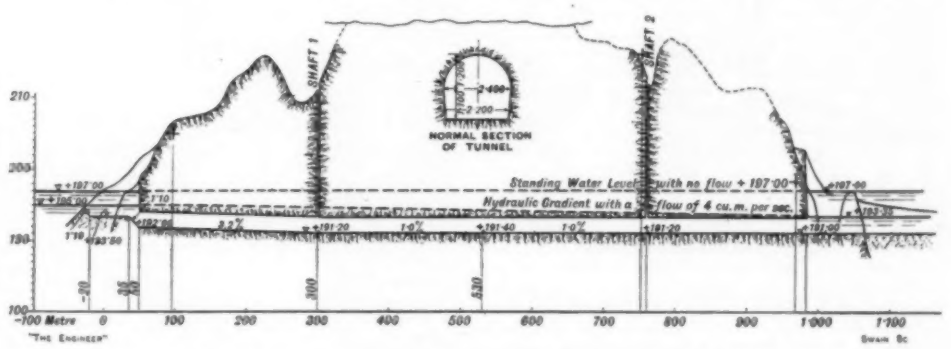


FIG. 7—LONGITUDINAL AND CROSS SECTIONS OF UPPER TUNNEL

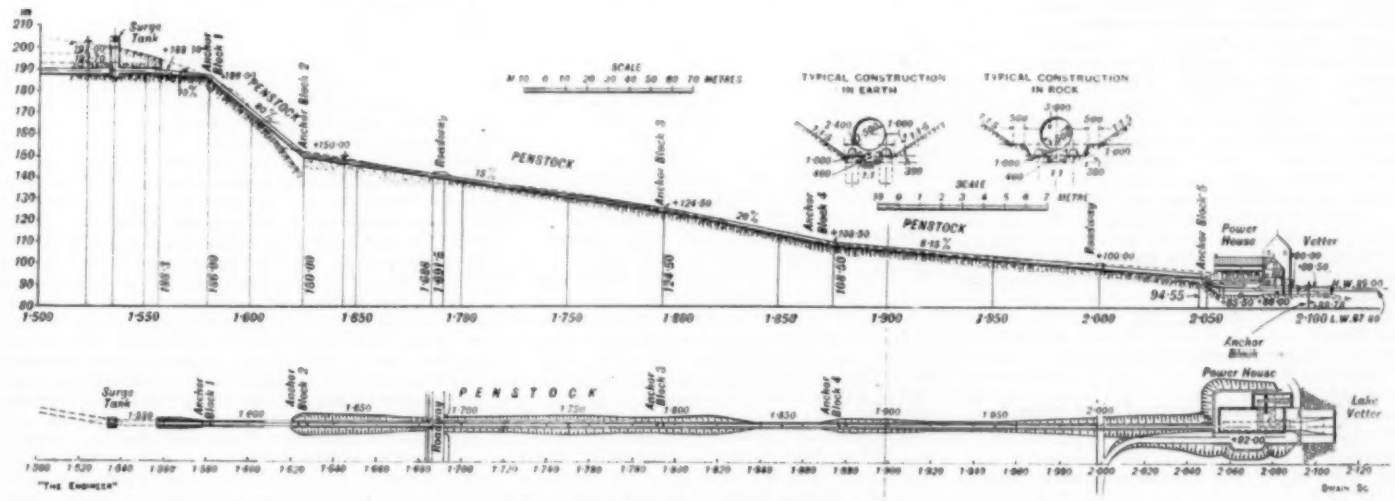


FIG. 5—ELEVATION AND PLAN OF PIPE LINE

As the pipe is adequately supported, and as the working stresses in the material are comparatively small, it was considered unnecessary to provide the valve with remote operation arrangements to be actuated from the power-house, or with some automatic relieving device, both of which would have added undesirable complications.

The line taken by the pressure pipe is shown in

Fig. 5. At the junction between the tunnel and the pipe a shelter is arranged as a protection against water dripping from the mountain. Where the pipe line traverses earth its bottom rests on a stone bed, and every 1·2 m. a row of upright stones has been arranged in order to decrease the velocity of water running down the slope of the hill. A similar arrangement, with small concrete sills placed at suitable intervals, has also been made where the slate rock encountered was of such a loose quality that the bottom could not be expected to withstand the velocity acquired by an unchecked stream of water. In addition to this, the track of the pipe line is drained by means of side outlets arranged at suitable points, and, where necessary, the drainage water is led through the anchor blocks by means of glazed tiles. Where the foundation consists of rock, the supports and blocks are founded on sound rock.

The pipe line—which is shown in Fig. 5 and of which three views also appear on page 268—has a length of 493 m. Its diameter decreases in steps from 1·6 to 1·4 m. Between the anchor blocks it is carried by supports furnished with roller bearings, spaced

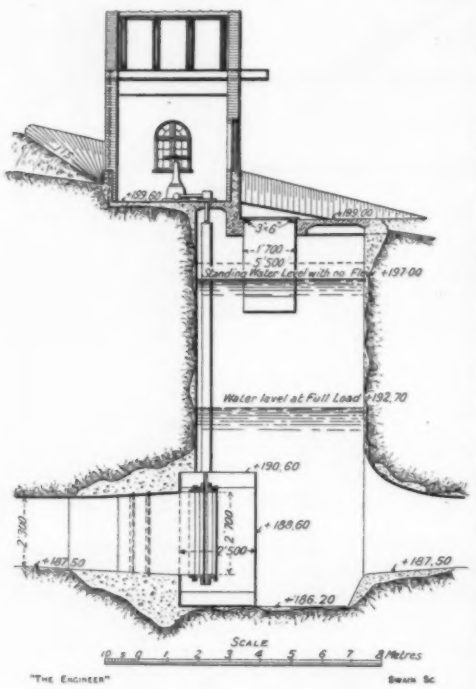


FIG. 8—SURGE TANK AT HEAD OF PIPE LINE

8 m. to 9 m. apart. The supports on both sides of the expansion boxes are placed in such a way that the centre lines of the pipe cantilevers are maintained parallel even when the pipe is under load. The water pressure at the power-house end, in the direction of the pipe centre line, which amounts to about 175 tons, is taken by a saddle-shaped, nearly horizontal steel frame, which is supported by two reinforced concrete brackets fixed between the rock foundation and the floor slab of the power-house. The contact between the frame and the brackets consists of ball-shaped thrust bearings. The distributing pipe under the power station is carried by two straps of rolled steel section fixed to the machinery hall floor.

The pipe line is made of steel plate of the qualities stipulated in "Normalbedingungen für die Lieferung von Eisenkonstruktionen für Brücken–und Hochbau, aufgestellt von Verband deutscher Arkitekten und Ingenieurverein." The maximum allowed unit stress in the material adopted for the design amounts to 900 kg. per cm.^{2} after deducting 0·5 mm. from all exposed surfaces subject to corrosion. The calculations have been worked out in accordance with the "Standard Specifications for Materials and Work in Structural Steel for Bridges and Buildings." Swedish Soc. C.E.

(To be continued.)

The Equilibrium Diagram.*

By W. ROSENHAIN, D.Sc., F.R.S.

WHEN a "scientific" President assumes office in this Institute, I feel that there may be some fear, among a section of our members, that the Institute will become more scientific—more "highbrow" than ever. I should like to allay that fear, if possible, by saying that no one will welcome more than I do papers of practical interest dealing with practical subjects. There is no function of this Institute which I value more highly than that of promoting interchange of ideas and experiences between practical men and between practical and scientific men who are interested in the same subject. Criticism is sometimes heard of the large number of scientific papers which are discussed and published by the Institute, and of their comparatively unintelligible nature for all except the trained scientific specialist. Something can, perhaps, be said in defence of these papers; they often deal with the very frontiers of our knowledge and embody the results of real exploratory or pioneering work. Provided the practical side is adequately represented in the publications of the Institute, the practical members should not, I think, grudge the time, space, and money which are devoted to the scientific aspect of the subject. It must be remembered that the world-wide reputation of our Institute rests largely on its essentially scientific work. There is, however, between the entirely practical, dealing with the details of works processes and methods, on the one hand, and the entirely scientific on the other, a large field of what should be common ground to all our members. The difficulties of practical metallurgy at times seek, or at least need, scientific assistance to overcome them, and scientific results are brought to the point by practical application.

One of the features of our *Journal* which sometimes provokes the good-natured criticism of our practical members is the frequency with which "equilibrium diagrams" occur. Perhaps I have myself been one of the sinners in this respect, either in person or through a number of my colleagues. The first paper which I contributed to the Institute at its first meeting in Birmingham in 1908 dealt with this subject—*i.e.*, with "The Metallographic Investigation of Alloys"—and related largely to the methods used in the determination of equilibrium diagrams. It will not be inappropriate, therefore, if in this address I attempt to give something in the nature of an explanation—even a defence—of the equilibrium diagram—an explanation and defence which are not required by the scientific metallurgist, but are addressed essentially to the practical man who may perhaps care to know why these things are determined, what they are, and how they can be applied to practical purposes. And although I have said that such an exposition is not needed by the scientific man, I make no apology for introducing it to the members of one of the most scientific metallurgical institutes in the world, because it is not a bad thing, even for the most scientific worker, to pause at times and consider the nature and possible practical utility of the work on which he is engaged.

Like many other scientific terms, the name "equilibrium diagram" appears forbidding to the uninitiated. In reality, it is quite simple. Let us think of an alloy system—that is, a series of alloys made by melting together two metals in various proportions—and let us, for the moment, think of simple alloys which contain only two metals. At first sight it would seem that to study those alloys we must examine each of them, make mechanical and other tests, and record the results in tables. Then, however, we find that we shall appreciate our results better if instead of merely recording our results in tabular form we try to represent them by a curve or graph.

A great many graphs connecting the various measured properties of alloys with their composition have been constructed and, taken by themselves, furnish results which are often anomalous and difficult to understand. The properties do not vary continuously, nor do they all vary in the same or even in a corresponding manner The alloys, in the great majority of cases, do not follow the rule of simple mixtures in which it is easy to calculate the properties of the mixture by the simple addition principle from the known properties of the ingredients. These things are not accidental, but follow exact laws and rules, and it is important for practical work with alloys to know those rules.

The position, when we come to study practical alloys, is still further complicated by the fact, well known to every practical man, that the properties of an alloy of given composition are not entirely fixed by the composition, but depend upon the treatment which has been given to the material. Here again we should suspect, even if we did not know, that there must be rules or laws behind these apparent irregularities, and again it becomes desirable to know and to understand those rules in order that we may not grope blindly for our desired results, but march to them along a well-defined road.

Study of the microstructure of alloys showed that there is a close connection between the microstructure and all the physical properties. One type of alloy has a comparatively simple structure, very similar to that of a pure metal; it consists of grains or, as we now know, crystals which are all alike in chemical composition, but differ from one another only in orientation—that is, in the direction of the lines on which each crystal is built up. All the alloys that show this type of structure have a certain similarity of properties, although that is a relative way of looking at them. Passing on from our first simple type of alloy in which there is only one kind of crystal, we come to what are called the "duplex" alloys—that is, alloys consisting of two different constituents. Here we find several different types, and again there is an intimate relation between microstructure and properties. So far, indeed, does this connection go that it can be relied upon to a considerable degree of accuracy not only in otherwise unknown alloy systems of two metals, but even in alloys of three, four, or more metals.

There are, of course, many features in the microstructure of alloys besides the simple or duplex constitution which have a direct bearing on the properties of the alloy; but at all events at this stage we may take it as established that there is a close connection between the microstructure and the properties of our alloys. If the connection between microstructure and properties of alloys is accepted—as it must be, in view of the mass of evidence that supports it—then our next question, in seeking for an explanation of the properties of alloys, is to ask what is the nature of these micro-constituents, and how are they formed?

This is by far the most difficult of the questions which we have so far considered. The full answer to it cannot even yet be given for all alloys and for all methods of treatment, but it can be given with certainty and clearness for the great majority of the alloys with which we are concerned in practice, and that answer is, simply, the equilibrium diagram. For the constituents of any alloy, at all events in its initial cast state, are formed either direct from the solidifying alloy or, subsequently, during cooling, by the interaction of the substances which are already present in the alloy. Much, as we know, depends on the rate of solidification and of cooling, and subsequent heating and working may produce further changes, but we need not allow these complications to confuse us in any way, for again there is rule and method behind the apparent complexity and confusion, and we find that for any alloy, and indeed for any series of alloys or alloy system, there is always one particular condition which the constituents tend to reach. They do not always reach it, because at low temperatures changes cannot take place, at all events in the harder metals, at any measurable rate. Thus an alloy, once cooled to the room temperature, is to all intents and purposes fixed—held rigid—in the state in which it happened to cool down from those higher temperatures where changes can and do occur at reasonably rapid rates. It is only if an alloy is held at such high temperatures for a sufficiently long time, or is allowed to cool exceedingly slowly, that it approaches this final condition. But it is still this final condition which all alloys tend to approach, and it is in the first place this ultimate condition—this limiting state—which we require to know and to understand. Then only can we approach the more difficult question of determining how far, with a given treatment, and especially with a given rate of cooling, that final state will be approached or departed from.

There is another reason why it is this final, ultimate state of our alloys that we need to study and ascertain; it is the only state which is definite and fixed for each alloy of given composition. Other states are in reality stages of transition. They are extremely important stages, but cannot be properly understood unless we realise that they are steps in a series of transformations or changes which are in some alloys so slow that the final state is never reached in practical working, while in others the final state is closely approached under ordinary working conditions. This final state towards which every alloy tends on cooling is what we call the "equilibrium" condition. It is, for a cooling alloy, exactly what "finding its level" is for water, and just as the interposition of a barrier of varying degrees of porosity, from that of sponge to that of cement, may retard or even prevent the attainment of its equilibrium level by water, so may the internal resistance to movement in an alloy retard or prevent its attainment of the equilibrium structure. It is doubtful whether in our laboratories we ever really attain true final equilibrium in the alloys we study, but we seek to approach this state sufficiently closely to enable us to judge correctly what that final state really is.

There is just one other point about these "equilibrium" states which it is necessary to bear in mind. As the word "equilibrium" itself indicates, these states are not essentially fixed and unchanging conditions, but rather states of permanent and stable balance. But the precise state in which such final balance will be reached depends on the temperature at which our alloy is maintained. For example, at a high temperature, well above its melting point, the alloy will be entirely liquid, and this liquid will be the condition of "stable equilibrium" under those conditions. What this means will be immediately understood if we think of a piece of the same alloy in the cold, solid state being introduced into the molten mass. Provided that the solid, cold piece is not so large as to chill the whole mass, or that a sufficient supply of heat is available to maintain the temperature in spite of any chilling effect, we all know what will happen—the cold piece of metal will be rapidly heated and, after a short time, will also melt or be dissolved in the molten alloy. For a short time, and for a short time only, solid and liquid alloy could co-exist, but very soon the balance between them is reached—by the melting of the solid. If, on the contrary, a small quantity of molten alloy is poured into a hole in a mass of cold solid metal, the molten material will very rapidly solidify. Here, owing to the low temperature, the balance is on the side of the solid state and the liquid rapidly disappears. It is clear, however, that at some intermediate temperature a condition might be found where the two states, the solid and the liquid, were capable of attaining an exact balance where solid and liquid can exist in a permanent state of balance or equilibrium, and this is actually the case. At the melting point such a state of equilibrium between solid and liquid exists, and so

* Institute of Metals. Presidential address, March 7th. Abstract.

long as the exact temperature required to produce this condition of balance is maintained so long does this state of equilibrium between solid and liquid continue. A rise of temperature gives the preponderance to the liquid, a fall to the solid.

If we wish to understand the behaviour of our alloys and the nature of the various constituents which the microscope reveals in them, we must seek to know as much as we can about these equilibrium or balance conditions which, as already pointed out, are by no means always attained, but which determine the kind of change which takes place at each temperature. In studying these we should, perhaps, find ourselves confused and liable to go far astray were it not that again a guiding principle has been discovered which tells us something about the kinds of balance or equilibrium which can occur in the various types of alloy. This principle is known as the "Phase Rule," and it applies to all systems or mixtures, so that it extends far beyond alloys into solutions and mixtures of all kinds, from the molten magmas which produced the igneous rocks of the earth's crust to the waters of the ocean or the mixtures in the beakers of the chemical laboratory. This Phase Rule is a kind of fundamental natural law which tells us nothing about the structure and constitution of real alloys, but it does tell us what that constitution must tend to become for given conditions of temperature, composition, and, where vapours are concerned, pressure, if the state of final balance or equilibrium is reached. It tells us, in the form of a simple numerical rule, how many different kinds of bodies can be present at the same time in true equilibrium when the three conditions named above are fixed.

It might be interesting to endeavour to give in a non-mathematical form the real basis of the Phase Rule, but I fear that it is scarcely possible—at all events I do not feel that I can attempt it here. I will content myself with indicating the kind of reasoning on which it is based. When two or more substances are brought into intimate contact, if their energy pressures or potentials are different there must be an immediate tendency to interchange, if such interchange can lead to a lowering of the average pressure or potential of the whole. This tendency to reduce the energy pressure to the lowest possible level, corresponding exactly to the running of water downhill to the lowest attainable level, is the moving force in all the changes which alloys and other mixtures undergo. It is, in fact, by working out the exact way in which this process of running-down of energy —"lowering of the potential"—can occur by changes from solid to liquid or liquid to solid, or from one kind of solid crystal to another, that the simple relation has been derived which we know as "Phase Rule."

In the study of alloys which I have so far asked you to follow in imagination, we have discovered a series of interconnections and regularities, and all or most of these we are now in a position to correlate with a kind of diagram which is not nearly so formidable as it may at first sight appear. If we realise that all the constituents which we find in our alloys as features of the microstructure are formed during cooling, it is natural that we should try to chart, in the simplest and most comprehensive manner possible, the various changes which occur in a series of alloys when they cool down from the molten state, and in making such a chart the "Phase Rule" is a most valuable guide. If we begin with a horizontal line divided from 0 to 100 to represent the percentage composition of our alloy series, we can plot temperature at right angles to that base line, and on the field thus formed we can insert every change which the alloys undergo. Thus we can begin by finding the precise temperature at which each individual alloy of our series begins to solidify; or, if we have suitable apparatus, we can determine the lowest temperature at which each alloy is completely liquid. If we mark the points thus found we obtain a very important and typical curve which metallurgists have called the "liquidus." Scientific metallurgists are often accused of inventing and using difficult technical terms, of which this word "liquidus" is a good example. But it is, in reality, just a kind of abbreviation. If we want to say exactly what that single word conveys we must say: "The curve joining all the temperatures at which solidification begins or melting is just complete," and if we were obliged to repeat such a phrase whenever there is occasion to refer to that kind of curve, it would make our papers even longer than they are.

In our equilibrium diagram many other lines can be drawn in it by connecting together various observed points. There are the temperatures of complete solidification on cooling or of incipient fusion on heating, which are connected by a line or series of lines known as the "solidus." Then, generally at lower temperatures, we find changes occurring in the alloys, either by interaction at a definite temperature between solid crystals already formed and the liquid still present, resulting in the formation of a new kind of solid crystal, or by the splitting up of one kind of solid crystal into two kinds. All these changes, and others which I cannot stop to enumerate, can be indicated on the diagram, and when all of them have been correctly inserted we have a complete chart of the various states of balance or equilibrium which alloys of the whole system tend to assume at each temperature and composition.

Before considering the utility and interpretation of these diagrams from the practical point of view, however, I wish to touch on two important matters connected with them. The first is the methods by which they are determined, and the second, which bears closely on the first, is the question: What degree of refinement and accuracy is necessary in order to render these diagrams fully useful?

The methods which have been mainly used in the construction of these diagrams are what is known as "thermal analysis" and the study of microstructures. For the former methods cooling and heating curves are taken, and signs of changes in the alloys are found as arrests or retardations of cooling or heating. This method has been carried to great refinement and still yields fundamentally important results. It requires, however, the study of the microstructure to complete its indications. This is not merely, as the earlier workers used it, the examination of the structure of the solid alloys cooled down to room temperature in a mould or even in the furnace. The true method was magnificently demonstrated by Heycock and Neville in their classical work on the alloys of copper and tin published in 1903. It consists in maintaining specimens of accurately known composition at a definite temperature for a time which is thought sufficient to secure a close approach to the equilibrium condition, followed by rapid chilling in order to avoid the intervention of possible further changes during subsequent cooling.

In addition to these, which may be called the "classical" methods of investigation, others have been developed. A very important one is known by the rather terrible name of "dilatometry;" it consists in measuring by very delicate means the changes in volume, or more usually in length, of specimens of the alloys when heated or cooled very slowly. This method has been developed originally in France by Chevenard, and has recently found extended application, by means of very beautiful appliances, by the late Professor Oberhoffer and by Dr. Max Haas, of Aachen, and by many others including Dr. Griffiths and Dr. J. L. Haughton in this country. Another method which is being widely used, especially in Japan, is the measurement of electrical resistance of alloys at various temperatures. It is, in fact, quite possible to use measurements of any physical property of metals which varies with temperature for the purpose of detecting irregularities which are, or may be, associated with changes in the alloys. None of these, however, appear to me to be so fundamental as the combination of the thermal and the microscopic methods. Indeed, there is reason to doubt whether there may not be important changes in alloys which do not make themselves felt in changes of all the physical properties.

Whether this degree of accuracy, or the still higher degree of refinement at which some scientific metallurgists are aiming, is really "worth while" is a question which is sometimes asked, even in scientific circles. In my opinion, there is no doubt that it is very well worth while. I think that this is particularly the case in regard to the study of alloy systems maintained in a state of very high purity. From the scientific point of view this increasing accuracy is desirable, because it will help to bring out more clearly the close inter-relation of different alloy systems.

Even from the practical point of view the highest degree of attainable accuracy in these diagrams is of much greater importance than would at first sight appear. It is true that industry does not and probably cannot work with extremely pure metals in the laboratory sense of the word "pure," but an exact knowledge of the effect of each unavoidable impurity is important.

I must not dwell longer on this question of the accuracy required in the determination of our equilibrium diagrams; although it is a subject in which I am deeply interested, it is a matter that concerns the scientific metallurgist rather than the practical man whom I am seeking to interest in these diagrams. This much, however, is of importance to scientific and practical men alike—that scientific guidance to industry demands the very best that scientific methods and resources can produce. It is only the most accurate and advanced work which, I am sorry to say, is sometimes brushed aside as merely "academic," that leads to those far-reaching results upon which our great industrial advances of the future must be based.

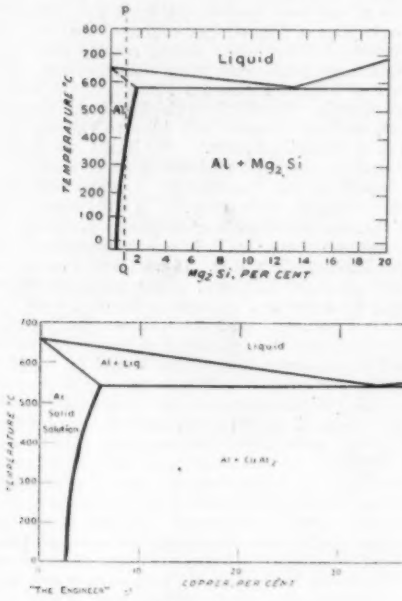
In order to emphasise this point and at the same time to give an illustration of the practical value of the exact determination of equilibrium diagrams, I now propose to deal with one line in these diagrams, and to show exactly how it is serving at the present time in the rapid development of new and important alloys and in guiding the treatment of older known alloys. The lines I propose to deal with are known to scientific metallurgists as "solid solubility" lines. These are lines which it is not very easy to determine, and there are still a number of important diagrams in which they are not properly known. In all the earlier so-called exploratory work on alloy diagrams these lines were entirely neglected. It was only the desire to obtain complete and accurate diagrams from the scientific point of view that led some of us to explore this side of the alloy systems, and the results of great practical importance that have since followed were not directly anticipated by those who were responsible for beginning the study of this part of the subject. It is another example of the way in which full and accurate scientific investigation often leads to unexpectedly important discoveries.

Let us think of a series of alloys produced by adding increasing quantities of one metal to another, beginning with the pure metal. Let us call it A, and add successive quantities of metal B. At first, in the great majority of alloy series the two metals not only mix readily—that is, "dissolve in one another"—when they are in the liquid, molten state, but up to a certain point they remain completely mixed or dissolved in one another even after they have solidified. The microstructure of the slowly solidified alloys tells us this at once, because we find, in such cases, that although there are two metals present, the alloy consists of only one kind of crystal—it is built up of only one constituent. It follows that both metals must be present in each individual crystal. We now know that the atoms of the two metals are built up together on the same plan or geometrical scheme—we call it a "space lattice." This really means merely that the two metals have preserved, after solidification, the same state of intimate mixture which existed while they were molten. We think of the liquid mixture as a solution, and we transfer this idea to the crystal and call it a "solid solution." Similarly, we speak of the extent to which a liquid can dissolve a solid or another liquid as the "solubility;" more strictly, it is the "liquid solubility." Thus water at 15 deg. Cent. can dissolve about 20 per cent. of copper sulphate and no more; this is the "solubility" of the copper sulphate in water. If we warm the water it will take up more sulphate, as the solubility rises with rising temperature, so that at 50 deg. Cent. it becomes 33·6, and we could plot a curve showing the connection between the solubility of the sulphate in water and the temperature. That would be a solubility curve for copper sulphate in liquid water. Exactly similar relations exist in the "solid solutions" which are formed when two metals crystallise together in the same individual crystals. They can, in some instances, do this in all proportions; in such a case, in whatever proportions we alloy the metals, the resulting material will still have a structure like that of a pure metal, consisting of one kind of crystal only. Copper and nickel, silver and gold, are examples of this kind of alloy, but from our present point of view these are less interesting than those in which the power of forming solid solutions is limited, where the crystals of metal A can only take up a certain limited proportion of metal B, so that, if more B is present in the alloy, a second constituent—a second kind of crystal—must be formed.

The most interesting and important results, however, have only come to light from the study of the exact limits of solid solubility. This simply means tracing out, over a wide range of temperature, from that of complete solidification down to room temperature or lower, the exact amount of the second metal which can be present in the alloy without the appearance, after sufficiently slow cooling, of a second kind of crystal. This determination is not easy. Thermal curves give no useful indication, and even dilatometry and measurements of electrical resistance are not entirely reliable. The most reliable results, however, are obtained by the microscopic method. In principle this is simple. We heat an alloy of a given composition at a given desired temperature, then we chill it as rapidly as possible. Then we examine it under the microscope in order to ascertain whether a second constituent is present. This requires careful and practised observation, but with care quite small quantities of a second constituent can be detected. Suppose we find that in specimens quenched from the temperature selected there is no trace of a second constituent. We next heat the same or another specimen of the same alloy at another temperature, considerably lower than the first, and again quench and examine. This time, perhaps, we find quite an appreciable amount of a second constituent and we try a third specimen, heated at and quenched from an intermediate temperature. Here we find on microscopic examination the merest traces of the second constituent, and we are justified in concluding that the limiting solubility lies between the two. If, now, we repeat such a series of experiments with alloys of other compositions, we will find for each of these lines two points, fairly close together, between which lies, for each alloy, the point of limiting solubility—*i.e.*, the point at which, in each alloy, the structure changes from that of a simple solid solution to that of a "duplex" material showing two constituents. As the alloy cools through this point, if it cools slowly enough, some of the second metal is rejected by the crystals of the solid solution, and this rejected portion forms a new kind of crystal.

If we consider a whole series of alloys, we can draw a line connecting those points of limiting solid solubility and thus obtain our "limiting solid solubility." Such a curve, although it conveys scientific information, does not appear of obvious practical importance, but in reality it has proved to be very important. In various alloy series these solubility curves take widely different shapes. In a few systems they appear to be very nearly vertical, and sometimes they lie very near the line which represents the pure metal. That means, in the first case, that the solubility of the two metals in one another does not change as the alloy cools, and in the other that there is very little solid solubility—*i.e.*, that the range of possible solid solutions is very short. These cases do not interest us at the moment, but I want to consider the

case in which the solubility curve slopes towards the pure metal side of the diagram with falling temperature. This means that at a high temperature it is possible to produce a solid solution containing a larger amount of the dissolved metal than can be dissolved or kept dissolved at lower temperatures. Such cases are fairly frequent, and we now know that they imply particularly interesting properties in the alloys concerned. I think that the first cases fully investigated were two of the series of aluminium alloys: those with copper in America by Merica, Waltenberg, and Scott, and those with magnesium and silicon at the National Physical Laboratory by Hanson and Gayler. The parts of the two diagrams which show the solubility curves are reproduced in Figs. 1 and 2, and, for



FIGS. 1 AND 2

the sake of clearness, the solubility lines have been drawn thicker than the rest of the diagram. Now let us consider a concrete example from the aluminium-magnesium-silicon diagram. This, it may be mentioned, is really equivalent to the diagram of a series of alloys of two simple metals, except that the place of the second metal is taken by a well-defined intermetallic compound, Mg_2Si, to which, for brevity, we may refer as "silicide." Let us consider the alloy containing 99 per cent. of aluminium and 1 per cent. of silicide, as indicated by the dotted vertical line P Q in Fig. 1. If we heat this alloy at 550 deg. Cent. and quench it, we find a simple solid solution structure, since we have quenched it from a temperature above the solubility curve. If, on the other hand, we either allow it to cool down slowly, or quench it from any point below the solubility line, we find a duplex structure—the second constituent, which in this case consists of crystals of magnesium silicide, can be seen in the microstructure.

Now let us consider the specimen quenched from the higher temperature. It has been brought down to the room temperature so rapidly that the second constituent has not had time to separate, and the alloy exists, when thus treated, as what we may fairly describe as a "supersaturated solid solution"—*i.e.*, it is a solid solution in which each crystal holds a larger number of silicide atoms built up in it than corresponds to normal equilibrium at room temperature—and there is, consequently, a strong tendency for things to right themselves, for changes to occur which tend towards the equilibrium condition. In some such cases, at room temperature, nothing will occur, because the internal rigidity of the crystals is so great that no movement can take place. In the aluminium alloys, however, conditions are fortunately not so rigid, and we find that, slowly, changes take place even at room temperature, although even here they are quickened very much if we heat the quenched alloy slightly. These changes consist in the gradual decomposition of the supersaturated solid solution, and the separation, in an extremely finely divided form of the excess of magnesium silicide from the aluminium matrix. This separation—we may well describe it by the chemist's term "precipitation"—of extremely fine particles of silicide throughout the aluminium solid solution crystals causes profound changes in their internal arrangement, and these changes bring about a gradual hardening of the alloy. This, in fact, is what is now fairly generally accepted as the mechanism of the well-known age-hardening of duralumin and similar alloys.

It was, I think, something of a metallurgical triumph to have solved the mystery of the age-hardening of duralumin in this way. The ingenious German discoverer, or inventor, of the alloy frankly admitted that he did not understand why it underwent these changes, which are vital to its usefulness. But the discovery of this process of age-hardening meant something far greater than the explanation of the mysterious behaviour of any one alloy or type of alloy. It was clear to those who appreciated what the discovery meant that age-hardening must be possible for any alloy lying in the range of a solubility curve which slopes in the same way as that of the silicide, or of copper, in aluminium. In any such alloy it should be possible to produce a supersaturated solid solution by quenching and then to produce hardening by subsequent "ageing," either at room temperature or at a higher temperature. And this prediction has been realised already in a number of alloys which have been or are being put upon the market. Unfortunately, the patent law permits those who exploit this discovery in regard to specific alloys to obtain patents for those alloys, while the original discovery, with all that it meant, was given freely to the world by both the British and the American investigators. The principle having first been established for a group of aluminium alloys has been applied to other alloy series of that metal, so that we now have a number of aluminium alloys or alloy groups capable of undergoing age-hardening in varying degrees.

It may be that some will ask of what use are these discoveries of new and remarkable alloys to the ordinary manufacturer or founder of brass and bronze—how do they help him to make cheaper or better castings, or sheet or tube? The answer to that question lies in two widely different directions. The first is, perhaps, the more consoling, since it is to suggest that although this particular aspect of metallurgical research may not be of direct benefit to those important branches of non-ferrous manufacture, there are others which offer direct benefits even to those old-established activities. I have, after all, dealt only with one example of the usefulness of equilibrium diagrams, and one example could not be expected to apply to many branches of industry. The second part of the reply to that supposed question may, perhaps, be somewhat disturbing. Is it quite certain that our age-old products, "ordinary" brass and bronze, will always be able to maintain their position? They owe that position to their superiority for certain purposes, and from certain points of view, to iron and steel. But that position is already threatened in some directions by the advent of the rust-resisting steels and iron alloys. In another sense it may be still further threatened by the advent of age-hardening alloys which may combine a greater resistance to corrosion with physical properties resembling those of steel, or even exceeding them. If that should be the case, even to a limited extent in the future, it becomes a matter of vital importance to the non-ferrous manufacturer to keep himself well abreast of such developments and not to leave the results of British discoveries to be exploited and patented abroad. These things may not help him to make better and cheaper brass and bronze as we know them to-day, but they may enable him to make in the future non-ferrous alloys that can hold their own with the best products of research as applied to iron and its alloys. This is no battle between "ferrous" and "non-ferrous," but friendly rivalry in the progress of both to the benefit of industry and of science also.

The British Industries Fair at Birmingham.

(*Concluded from page* 237.)

TO-DAY we conclude our account of the exhibits at the Birmingham section of the British Industries Fair, which ended on Friday, March 2nd.

LONG AND CRAWFORD, LTD.

Many engineers associated with electrical distribution will be interested in the so-called "Metesco" ring breaker, designed by Mr. A. F. Harmer, and exhibited by Long and Crawford, Ltd., of West Gorton, Manchester. Some time ago Mr. Harmer devised a scheme of high-tension distribution for a supply in the London area to enable transforming points to be added as required. Assuming the centre of the area to be the point where the current is generated or obtained, the scheme involves running a fringe ring round the area and connecting this ring by "spoke cables" to the centre in the manner shown in the diagram, Fig. 33. As additional "spokes" and cross ties can be put in as the load demands, the system is very flexible, whilst large consumers, such as stores, blocks of flats, and offices requiring from 100 to 300 kVA can be fed on the ring or "spokes" at 6000 volts and the pressure can be reduced on the premises. In the plan—Fig. 33—the large centre sub-station receives the supply at 22,000 volts, and current at 6600 volts taken from the secondary side of the transformers is fed into the ring through the "spokes." The circles on the plan represent the supply undertaking's sub-stations, in which the pressure is reduced to feed the network, whilst the dots indicate some of the existing consumers' sub-stations, and it will be noted that all the sub-stations are fed from at least two points. The boundary of the area is shown by the chain line. When considering the problem of how to make the best job of the connections to 6600 volt consumers, the most important point to remember is that it is essential to be able to add to the number of sub-stations without undue interference with existing consumers, and it is also important to be able to cut out faulty sections of cables. This eliminates the usual method of teeing off in the street, and introduces the "loop in and out" system. It is desirable to employ the minimum amount of gear at each sub-station, especially in London, where there is difficulty in obtaining adequate space for sub-stations on consumers' premises. The gear must be able to meet the following conditions:—(1) The ring or "spokes" must be capable of being broken at each transforming point; (2) it must be possible to isolate a transformer without interfering

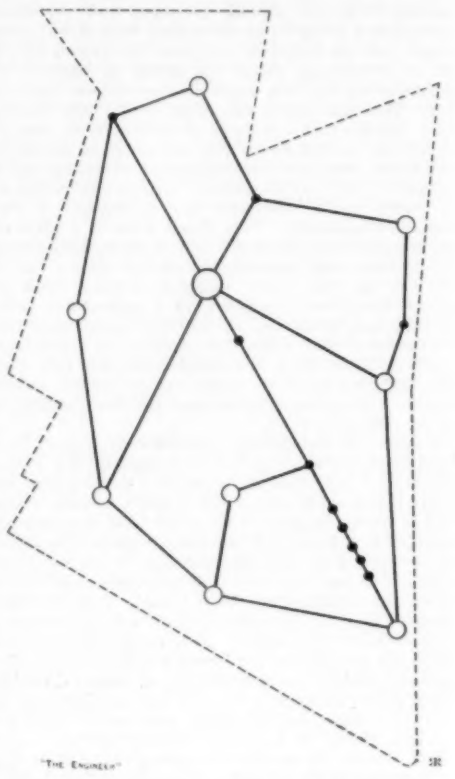


FIG. 33—DISTRIBUTION SYSTEM

with the ring; (3) the transformers must be fed from either side of the broken ring, either when the ring is closed or open; (4) the space taken by the equipment must be small; and (5) the cost must be low.

The first three conditions can be met by employing three cubicles or trucks, each containing an oil switch and isolators, but the two last requirements make this practice impossible. As Mr. Harmer was unable to obtain anything suitable from any of the switchgear manufacturers, he designed the "Metesco" ring breaker shown in Fig. 34, which, as we have

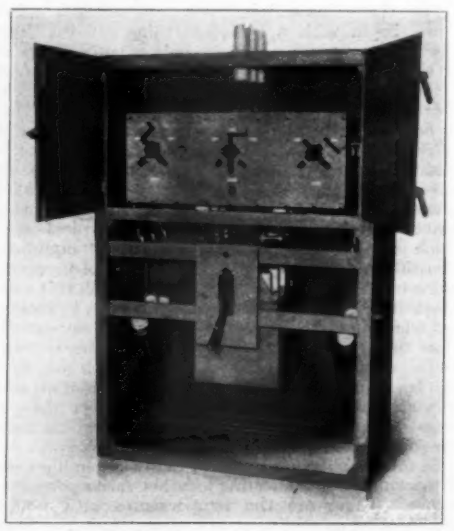


FIG. 34—SWITCH UNIT—LONG AND CRAWFORD

said, is manufactured by Long and Crawford, Ltd., of West Gorton, Manchester. The breaker is contained in a sheet steel cubicle, 5ft. 9in. high, 3ft. wide and 1ft. 9in. deep, and when it is placed against the wall it occupies very little space, height generally being of no particular importance. Inside the case there are two standard cable end boxes, which may be placed vertically or horizontally to suit the cable arrangements, or, if necessary, they can be placed outside the case. The cable tails which leave, say, the left-hand box, are bolted to copper bars, to which the contact jaws of the first rotary isolator are attached, whilst from the other contact jaws of this isolator the current

passes down to an oil switch and then up to another similar rotary isolator on the right, and, finally, away through the second cable box. The ring or "spoke" main is therefore broken by the oil switch. As the switch never has to operate on fault conditions, it need not have a great rupturing capacity, and as protection is provided at each feeding end of the cable, it is not provided with automatic protective gear. Between the two rotary isolators mentioned, additional contact jaws are provided for a third rotary isolator with blades 90 deg. apart, so that, as will be gathered from Fig. 35, the load can be fed from either cable box irrespective of the oil switch. The three

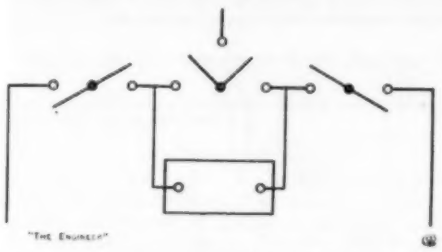


FIG. 35—ARRANGEMENT OF SWITCHES

rotary isolators are provided with locking arrangements, so that each can be definitely fixed in the "in" or "off" positions, and spring catches are provided to hold the isolators until they are locked. The doors which cover the lower part of the cubicle where the oil switch is situated cannot be removed whilst the oil switch is closed. In closing, the upper doors fix the lower doors and prevent any movement of the oil switch handle, which extends through the lower doors. The handle operating the upper doors is provided with a standard padlock, the key of which is taken care of by the mains engineer or his deputy. The oil switch is slung in a cradle, so that it can readily be removed. In Fig. 35 the ring is open, the oil switch is isolated on each side, and the transformer or other circuit is also "dead." At A in Fig. 36 the ring is closed and the transformer is still dead. At B the ring is closed and the transformer is alive; at C

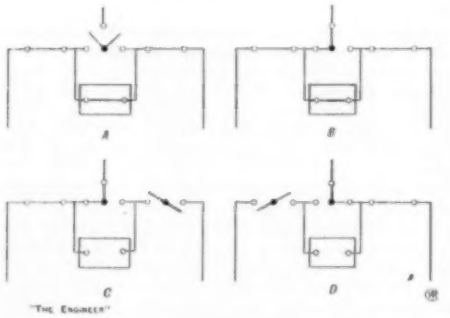
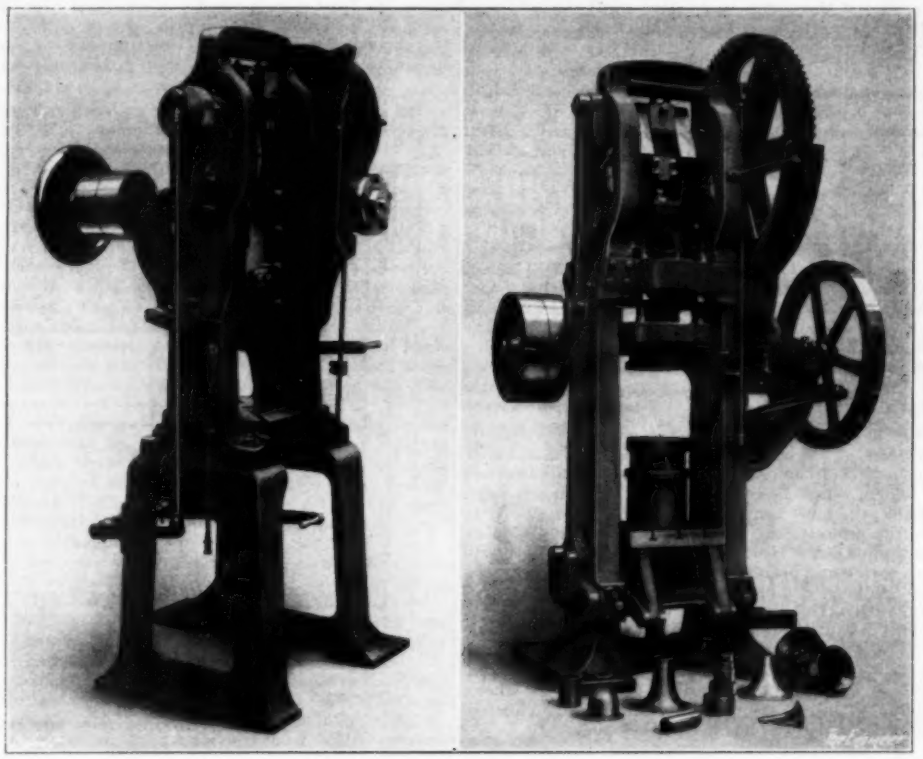


FIG. 36—SWITCHING OPERATIONS

the ring is open, the oil switch is isolated on the right-hand side, and the transformer is connected to the left-hand side; lastly, at D the ring main is open and the oil switch is isolated on the left-hand side, whilst the transformer is connected to the ring on the right-hand side. These cubicles may also be used for interconnecting cables by coupling two or more cubicles in various ways.

HORDERN, MASON AND EDWARDS, LTD.

Of the several presses on the stand of Hordern, Mason and Edwards, Ltd., St. Mary's, Birmingham, one of the most interesting was that illustrated by Fig. 37. It is intended for the forming of materials of compositions such as Bakelite, which must be worked hot and must have the pressure maintained upon them while they are setting in order to ensure that the corners are really sharp. For such purposes an ordinary spur-driven press is not entirely satisfactory, as there is a tendency for the press to run back when it has been stopped at the bottom of the stroke, with the consequence that the material re-expands slightly and the corners become rounded. This trouble is overcome in the press under notice by driving the main crank shaft by means of worm gearing which is of such a pitch that it is irreversible; that is to say, no effort applied to the crank shaft will make the worm rotate. The worm shaft is driven through a friction clutch by the belt pulleys shown in Fig. 37 or by an electric motor, as was the case at the Fair. The clutch is operated by the striking gear seen on the right of the machine and may also be manipulated by hand. Connected with the same gear there is also a brake, which is applied directly to the worm shaft to ensure that it stops immediately and to make doubly sure that the worm does not run back. The table is so equipped that the dies can be heated by gas jets, or any other convenient means. In operation the upper tool is warmed up by holding it in the lower die for a short time. The tool is raised and the die is filled with material. On the next stroke the tool stops automatically at the bottom of its stroke and remains there until released by hand. The press exhibited is capable of making articles up to 4in. deep, but other larger sizes are made by the firm. The press shown in Fig. 38 is intended for drawing unusually deep articles, and was shown in operation making the second pass for metal hot-water bottles. As will be seen from the illustration, both the ram and the table are movable and are worked off one crank shaft. The ram is worked



FIGS. 37 AND 38—BAKELITE AND DEEP METAL DRAWING PRESSES—HORDERN, MASON

directly by a connecting-rod from a central crank and the table by a train of linkage, which gives a toggle at the end of the stroke. In operation the top tool starts to come down first and then the table rises to meet it. The tool retires upwards and as the table falls again the job is stripped from the dies. The press shown is capable of drawing articles to a depth of 12in.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, LTD.

One of the aims of those responsible for the design and maintenance of cable networks is to ensure that all joints have the greatest possible factor of safety. It is generally agreed that lead sleeve joints, or joint boxes having plumbed brass glands, afford a high factor of safety, but the process of making such joints calls for skilled workmen who are not always available. With a view to simplifying and improving work of this nature, an automatic plumbing apparatus has been developed by Callender's Cable and Construction Company, Ltd., the important features of the apparatus being that the temperature of the metal, the shape of the joint and the pressure exerted upon the lead sheath are all under control. Copper dies are heated by detachable elements, which are heated, in turn, by blow lamps, the copper dies being raised to a predetermined maximum temperature. The dies which have a taper bore are used in conjunction with lead alloy cones, which are lined with an alloy having a higher tensile strength and lower melting point than lead for which it has a natural affinity. When the joint is being made, the temperature of the dies is limited, and the lead sheath and cable are immune from damage, but the lining of the cone becomes molten. Owing to the use of a special flux and the compression of the lead alloy cone and consequent exclusion of the air by means of the taper die, the joints are said to be capable of withstanding a pressure of 250 lb. per square inch. Continuity of the lead sheath is ensured by tinned copper bonds, which are cast into the lead cones. These bonds are connected to copper bonding strips which extend across the joint box and are rigidly bolted to the box and armour clamps, thus giving exceptionally efficient bonding. After the cable ends have been cut to the correct length, the armour clamps—see Fig. 39—are pushed back over each end of the cable, and the armour wire is bent back sufficiently to expose the lead for the requisite distance. If the lead sheath is not circular, it is hammered into shape with a wooden mallet, and it is thoroughly cleaned and scraped. The insulation is removed, and the cable ends are prepared for jointing in the ordinary way. In order to ensure that the correct pressure is applied to the lead sheath, the sheath is scraped away until

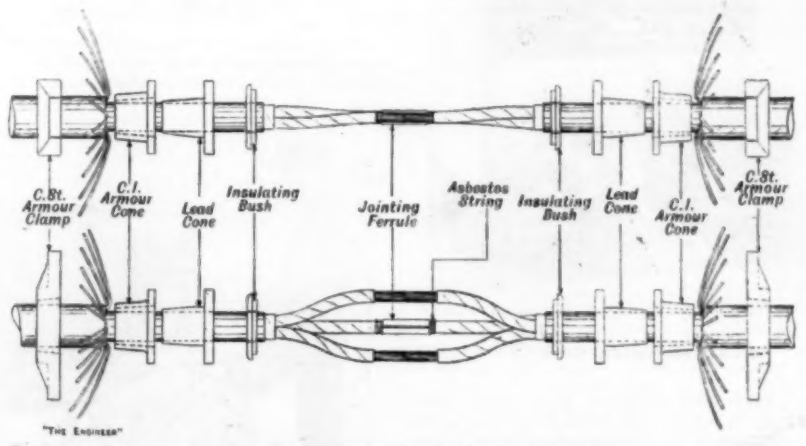


FIG. 39—THREE-PHASE CABLE JOINT—CALLENDER

a definite specified clearance is secured between the sheath and lead alloy cones. Having attended to this matter, the jointer then cleans the lead sheath with a file card and applies the flux to the sheath and cones. He then slides the cast iron armour cones and lead alloy cones over the ends of the cable with the flanges of the lead cones towards the centre of the joint, as shown. When the conductors have been joined in the ordinary way, the cast iron joint box is placed in position and a two-part heating die is selected that fits the lead alloy cone. After the two parts of the die have been placed in position on one of the cones they are bolted together so that their faces meet, thus automatically placing the die in the

correct position on the cone. Heating elements are then placed in a socket in the heating die, as shown in Fig. 40, and are held in intimate contact with the die by set screws. A slotted clamp plate—see Fig. 40—is then placed behind the die, and is bolted up by the bolts that are afterwards used for securing the armour clamp. The die is pulled up until its inner edge is approximately a quarter of an inch from the outer face of the flange, when the inner surface of the cone should be in intimate contact with the lead sheath. Two blow lamps attached to special supports are then applied to the heating elements, and they are allowed to remain in position until the solder is melted on the face of the lead alloy cone within the heating die. The joint is then allowed to stand for a

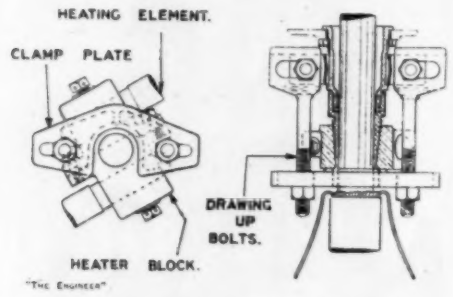


FIG. 40—HEATER BLOCK AND CLAMP

period of two minutes, the die being pulled up slightly by means of the bolts on the cable box. A neat finish is provided at the end of the cone by the application of solder, which is wiped clean in the ordinary way. Finally, the blow lamps and heating die are removed, the iron armour cone and armour wires are placed in position and the armour clamps are fixed in accordance with usual practice. When the plumbing operation has been completed, the joint box is filled and completed. The plumbing of tubular brass glands is carried out in the same way, but the T-headed slotted bolts are used in conjunction with the ordinary wrought iron armour clamps, provided with the box. For use in fiery mines and in other places where explosive gases are present, electrically heated plumbing apparatus has been developed.

The Lancashire Dynamo and Motor Company, Ltd.

The "Maxtorq" motor described in our issue of July 22nd of last year was one of the exhibits of the Lancashire Dynamo and Motor Company, of Trafford Park, Manchester, which was also showing a new direct-current motor and rectifiers suitable for various

FIG. 41—RECTIFIER—CRYPTO

purposes. While the efficiency of a small motor generator may be appreciably below 60 per cent., that of these commutator rectifiers is considerably higher, and for cinema arc lighting equipments, &c., they show a marked saving in the current consumption as compared with that of motor generators. The makers of these rectifiers state that a motor generator supplying an ordinary cinema arc demands about 4½ units per hour. With a mirror arc a motor generator takes about 3 units per hour, but a rectifier can work a mirror arc with a consumption of about 1½ units per hour. The mirror arc has largely replaced the straight arc because it is economical, but when a motor generator is employed for providing the direct current the maximum possible efficiency cannot be obtained. Another advantage claimed for the rectifier is that it produces an exceptionally white light. The rectifiers are made by the Crypto Electrical Company, which is associated with the Lancashire Dynamo and Motor Company. The general principle was described in the series of articles on rectifiers published in our columns between July and September of 1925. Briefly these rectifiers consist of a synchronous motor worked from the alternating-current supply, which also feeds a static transformer, and the alternating current from the secondary winding of this transformer is converted into unidirectional current by means of a commutator mounted on the synchronous motor shaft. Four brushes bear on the commutator, two of which deal with the alternating current, whilst the other two feed the direct-current circuit to which the load is connected. A complete rectifying outfit for a cinema arc lamp is shown in Fig. 41. The synchronous motor is self-starting and the whole apparatus can be set to work in a few moments.

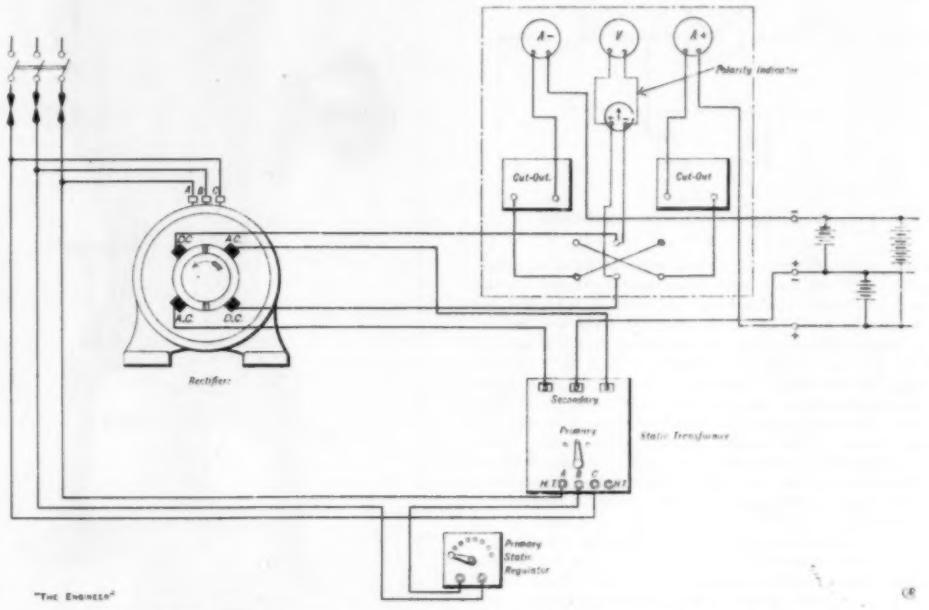


FIG. 42—CONNECTIONS FOR BATTERY CHARGING RECTIFIER CRYPTO

The reason a rectifier of this type is much more efficient than a motor generator is pretty obvious, for whereas in a motor generator all the power supplied to it must be first converted into mechanical power and then back again to electrical power, in the case of the rectifier the motor merely revolves the commutator which rectifies the current. A rectifier suitable for charging wireless, motor car, and other batteries was also exhibited, and a diagram showing the connections is given in Fig. 42. It will be seen that the equipment is designed for a three-phase supply and that the direct-current supply is given on the three-wire system by taking a tapping from the secondary of the transformer. Two pressures are thus made available and 6 and 12-volt batteries can be charged on the constant-potential system. Charging equipments are made for other pressures, such as 8 and 16 volts, and as no series resistances are employed they are highly efficient.

Marryat and Place.

On the stand of the City of Birmingham Electricity Supply Department there was shown in operation by Marryat and Place, of 40, Hatton-garden, London,

FIG. 43—ELECTRIC RIVET HEATER—MARRYAT

one of the firm's latest type of portable electric rivet heating machines. In general appearance the machine is represented by Fig. 43, but in the new design some improvements in small details have been made, and the switch mechanism which in our illustration is shown uncovered beneath the machine is now totally enclosed. At each side of the machine a handle is provided, which works the switchgear through a bevel wheel drive, and gives the operator the choice of four heating speeds. The machine is of the two-head air-cooled type. It has a rated capacity of 10 kW, and is the smallest size made. As demonstrated to us, it was performing the heating of ⅜in. diameter rivets about 2in. in length, which were thoroughly heated from the centre in less than 10 seconds.

The operation is an exceedingly simple one, all that is required being to depress the treadle and insert the rivet between the upper and lower heating heads, and then to release the treadle. The rivet closes the secondary circuit of the transformer, and the slight resistance which is set up by it is sufficient to impede partially the passage of the secondary current, with a resulting rapid heating. When the rivet has been heated to the desired point of redness, the treadle is again depressed, and the rivet removed by the tongs. As the voltage across the heating heads is in the neighbourhood of 1½ to 2½ volts the makers claim that there can be no danger of shock to the operator.

As will be seen from Fig. 43, the machine is mounted on wheels and it is also furnished with four eyebolts for slinging, so that it can quickly be transferred from one part of the shop to another or lowered into a ship's compartment. In the machine we illustrate the two heating heads are air cooled by means of laminated copper fins, but in the large sizes of machine, which have three heating heads and capacities up to 45 kilowatts, water-cooled heads are provided. The makers claim that as electrical heating takes place from the centre outwards, there is less scaling than with other forms of heating.

Bull Motors, Ltd.

A machine of considerable interest to wireless engineers was shown by Bull Motors, Ltd., of Ipswich. Progress in wireless telegraphy and telephony has made some very exacting demands upon the technical resources of those firms that have been courageous enough to keep pace with the times, and some rather

FIG. 44—H.T. MOTOR GENERATOR—BULL MOTORS

extraordinary machines have been developed. The machine shown in Fig. 44 is a motor generator that has been designed for use with ships' wireless sets. One section of the double armature which is shown in Fig. 45 carries the motor winding and also an auxiliary generator winding for supplying 275 watts at 25 volts for heating the valve filaments, whilst the other armature is wound to give 0·5 ampère at 2400 volts for the high-tension circuit. The set revolves at 3000 revolutions per minute. The high-pressure

end, which is claimed to run as well as any high-class industrial motor, has been subjected to a flash test of 5000 volts to earth. In the design of these sets every endeavour has been made to eliminate com-

FIG. 45—DOUBLE ARMATURE BULL MOTORS

mutator ripple and in the latest models this is claimed to have been achieved.

OTHER EXHIBITS.

Among other exhibitors there were the Laughton Packing Company, of 199, Princes-street, Manchester, with a display of hydraulic leathers, packings, jointings, &c.; Messrs. Moore and Wright, of Sheffield, who had one of the most extensive shows of engineers' small tools; and Smith Bros. and Hill, Ltd., of Tipton, who exhibited springs of all sizes from those necessary to control the gates of the Gladstone Dock down to little things for calculating machines that needed a pair of tweezers for handling. On the stand of the British Rolling Mills, Ltd., Tipton, we saw a very interesting chart for determining the hardening temperatures of various qualities of steel; while the Soldo Company, of Sicilian House, Southampton-row, London, W.C. 1, demonstrated the merits of their tinning compound, which have already been recounted in THE ENGINEER. R. A. Lister and Co., Ltd., of Gloucester, exhibited a number of comparatively small petrol engines and some of a larger size for working on paraffin.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BALANCING FOUR-CYLINDER AND THREE-CYLINDER LOCOMOTIVES.

SIR,—The article in THE ENGINEER of November 19th, 1926, on the "Lord Nelson" class of ten-wheel locomotive of the Southern Railway, in regard to the counterbalancing on page 560, states:—"In the case of the reciprocating weights a compromise has, as usual, been made between complete balancing, which results in a large variation in the rail pressure, and an absence of balancing, which may produce among other effects *a dangerous swaying couple at high speeds*."

The writer always reads with interest statements and opinions that may be expressed by the editors of THE ENGINEER or by engineers of the large English railway systems, or by such an authority as Professor Dalby.

However, sometimes there is a great difference between what the theory seems to show and what we actually find or get. Take a four-cylinder locomotive with the cranks set evenly on the four quarters, or unevenly as on the Southern Railway "Lord Nelson" engine, with the reciprocating parts, piston, piston-rod, crossheads, parts of main rods weighing the same, or inside or outside parts weighing differently.

Take such a case. According to the theory, if none of the reciprocating parts are balanced there should be a swaying moment, causing a heavy swaying of the locomotive from side to side at high speed. That is what part of the theory shows. Actually, *with no reciprocating parts balanced*, there will be no swaying at high speed. Instead the engine will be most amazingly steady at high speed.

And, if the theory is analysed far enough, after all it is not contrary to the actual results. What has been omitted in the calculations is the "time element" and the effects of the mass and the rigid wheel base of the locomotive. It takes time for a force or impulse or swaying moment to have its effect on the large mass of a locomotive. The disturbing impulses on a four-cylinder locomotive at speed come so fast that they counteract and break each other up and the actual result is a mass of locomotive that remains still.

During the time that the four-cylinder balanced compounds were running on some of the American railroads this matter of counterbalancing was studied most thoroughly and tested on models, and tried out actually on the engines. Take an "Atlantic" type four-cylinder compound with high-pressure cylinders 15in. diameter, low-pressure 25in. diameter, stroke 26in., diameter drivers 79in., pressure 225 lb. These engines had two 25in. diameter low-pressure cylinders placed outside the frames. Not one pound of the reciprocating parts of the inside or outside cylinder was balanced in the wheels. The revolving weights were balanced only, and these completely and exactly.

At high speed—and one of these engines had an authentic maximum speed of 102 m.p.h.—there was not the slightest tremor fore or aft or sideways or crosswise.

Now, this same engine at a certain low speed, about 25 m.p.h., had some swaying motion from side to side. It was a noticeable sway felt from front to back of the engine. At a speed slightly above or below this critical speed all swaying disappeared—not a sign of it. This critical speed was different for different engines, depending on their total mass, weight, and position of parts.

What was happening was that at this particular speed certain moments were combining together, all in one direction, tending to turn the engine across the track. They all synchronised together and these impulses were not coming quick enough to break each other up and neutralise one another.

What has just been stated about the four-cylinder engine is equally true about the three-cylinder engine. The Philadelphia and Reading Railroad some years ago had some three-cylinder "Atlantic" type engines running, three cylinders all 22in. diameter, 24in. stroke, 80in. drivers, 240 lb. pressure, cranks 120 deg. Not one ounce of the reciprocating parts was balanced in the driving wheels, while the revolving weights were most completely and accurately balanced.

The writer rode on these "Atlantic" type three-cylinder engines, front, back, and in the middle. Authentic speeds up to 100 m.p.h. were often made. At the highest speed the engine was marvellously quiet, no swaying, no jerking fore and aft, no rolling. With the three-cylinder, as with the four-cylinder, there was a certain low and critical speed when a swaying motion was noticed, but it was at low speed. The slightest increase or decrease from this critical speed and all swaying disappeared.

In these four-cylinder or three-cylinder engines there was no hammer blow; that is, no dynamic augment under the driving wheels. The driving wheels carried only their static loads.

To work out and to include mathematically in the counterbalance calculations the time element and the mass effects of the engine, and length of rigid wheel base, would show, if the reciprocating parts *were left entirely unbalanced*, that at one speed, and one only, would there be any actual swaying. But it would be a very involved problem to work out.

For slow, medium or high speed three-cylinder or four-cylinder locomotives balance none of the reciprocating parts. It is not necessary. The engines will be very quiet from zero speed up to maximum, except at some one rather low speed. Find out this speed for each type of engine and do not run at that speed, simply avoid it.

Summing up, mathematics could be made to show, and actual tests and many trials have shown, that there is no good reason ever to have any hammer blow, that is, dynamic augment, in any three-cylinder or four-cylinder locomotive. And yet such an engine will run amazingly smoothly with none of the reciprocating parts balanced in the wheels.

H. A. F. CAMPBELL.

Baldwin Locomotive Works, Philadelphia.

DIESEL ENGINES AND PEAK LOADS.

SIR,—The writer of the article under the above heading, published in your issue of January 20th, 1928, is to be congratulated in bringing such an important matter to the fore at such an opportune time. This article, together with the subsequent very able discussion, provides considerable food for thought to those right-thinking engineers who are interested in the important matter of cheap supply of electricity.

There are at the moment thirty-three electricity undertakings in this country which are members of the Diesel Engine Users Association, and therefore have as prime movers, Diesel engine plant. It is most interesting to note that these station plants are able to operate on a fuel cost varying from ·309d. to ·499d., the latter figure, of course, being the exception, and the lower figure being nearer the average.

It is most interesting to compare these fuel costs with those stations where no Diesel plant is installed, and where it is possible for such stations to show a much higher load factor. The figures are published from time to time in the *Electrical Times*.

The Epsom station, which I control, which is the smallest municipal generating station in the South-East England electricity scheme, contains Diesel, semi-Diesel and steam reciprocating plant, and there is no doubt that this latter plant should have been replaced by Diesel plant many years ago. Under such conditions it is not possible to produce any startling figures. The conditions do, however, show quite plainly the many advantages of the Diesel engine over the steam plant, and in spite of the adverse conditions the thermal efficiency is at present 20 per cent. Only one steam station—Barton, of Manchester—can beat this. The average thermal efficiency of the selected steam stations is 12·38 per cent., the lowest being 5·83 per cent. and the highest 15·95 per cent. Any well-designed Diesel station can run at over 25 per cent. thermal efficiency. I doubt if any steam station will ever do this. With Diesel plant, the Epsom electricity undertaking, with an output of under 2,000,000 units, can easily beat the County of London Company's stations on fuel costs, with their 145,000,000 units, and another really interesting comparison is that the Worthing electricity undertaking—all-Diesel—last year sold 3,056,261 units with a fuel cost of ·42d. per unit, compared with the Brighton super-steam station and its 23,535,249 units sold at ·64d. per unit for fuel. Here you have a steam station nearly eight times the output of a Diesel station costing 50 per cent. more for fuel during a crisis, but even in normal times these two stations with their great difference in output were equal to ·44d. on fuel costs.

If any engineer will take the trouble to compare the fuel costs of all the supply authorities in the South-East England scheme, they will find only three—Hackney ·27d., South Metropolitan ·28d., Whitchurch ·24d.—stations below ·30d. per unit for fuel, and eighteen below ·40d. per unit, all the others varying above ·40d. per unit up to 1·68d. per unit.

The Diesel engine of to-day is as reliable and certainly more efficient than any other type of power plant, and, moreover, it has the advantage that it has no "stand-by" losses, and can be run up from cold to full load in from one to five minutes, according to the size of plant, and, moreover, it takes up less room than similar size steam plant.

For peak loads, and particularly for one-shift or two-shift stations, a Diesel plant cannot be beaten, and, moreover, there is no question of the disposal of ashes and clinker, which item to the larger London stations must be very considerable.

It is interesting to note that the city of Geneva, after carefully investigating the claims of Diesel engines and steam turbines, has decided to replace its present steam turbine plant with two Diesel engines of 3000 H.P. each. This plant will be used as stand-by plant, and for use on peak loads, for which purpose the Diesel engine cannot be surpassed.

Having adopted the American method of transmission, I feel sure it would be of benefit to our industry if the Electricity Commissioners and the Central Board were to look into the methods now being adopted by our continental friends as regards the use of Diesels for peak loads, and one or two shift stations.

It is to be hoped that those in authority over our industry will at least allow those stations where Diesel plant is installed to use it for peak loads. Where stations are allowed to extend with Diesel plant, and this is used on peak loads, it will be found that this plant will pay for itself in a period of five years.

H. W. WATTS,
Resident Electrical Engineer.

Epsom, Surrey, March 5th.

THE BRITISH INDUSTRIES FAIR.

SIR,—During the period of the Birmingham British Industries Fair, I had opportunity to meet quite a number of other exhibitors and customers who seem to express a few views which those responsible for the management might perhaps take into consideration.

First, is it necessary to have the White City Fair and the Birmingham Fair at the same dates? The Birmingham Fair is largely for the hardware, electrical and heavy industries. These to a great extent are not seasonal trades, and this Fair is supposed to be for the special benefit of the export trade. The general opinion was expressed that the date—the end of February—was wholly unsuitable for the purpose of attracting colonial and South American buyers.

The season at which the general influx of visitors to Great Britain from the Dominions and abroad is at its height, is towards the end of May or beginning of June, and these are the customers whose interest we, as exhibitors, particularly desire to attract. But at the 1928 Fair they were largely noticeable by their infrequency.

The opportunities at this Fair to meet potential Empire customers do not seem to be provided by a date in the middle of February.

As regards the home trade, my firm circularised its customers regarding this Fair, and received a considerable demand for tickets from ironmongers and the like; in fact, these continued to come in during the Fair. But the system at the door, whereby the admission tickets were taken from the holders was rather an abuse. The Fair is so big that a customer wishing to examine the exhibits cannot do so in one day, and he must either have another ticket or pay 2s. 6d. to come a second time. The general admission of the public during the fair is also a matter on which opinions can be expressed. It means that all price lists with discounts to the trade must be withdrawn and every visitor to a stand questioned closely as to his business. One or two days should be strictly reserved to the traders, and on these days the public should not be admitted.

Finally, a word as to the railway arrangements. I travelled several times from Euston on the 9.10 express to Birmingham, but there was no through booking to Castle Bromwich, and although extra carriages were put on which could have been attached to the 11.20 train to Castle Bromwich, this was not done in either direction, and the overcrowding of the trains was such that at the end of a tiring day, many people were reduced to a stage of complete exhaustion.

Yesterday, particularly, I noticed whenever a chair was placed in a vacant space, it was seized by tired visitors. Surely more could be done in this matter, as it is a truism to say that the more the comfort of a customer is catered for, the more chance is there of his paying another visit.

For RD. JOHNSON, CLAPHAM AND MORRIS, Ltd.,
A. L. JOHNSON,
Chairman and Managing Director.

London, E.C. 3, March 2nd.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, March 5th, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The Secretary announced the decease of Sir Dyce Duckworth and Mr. Alexander Siemens, and resolutions of condolence with the relatives were passed. Mrs. Dick, E. J. Glyn, L. V. Haigh, W. A. H. Harding, H. S. Harron, Mrs. C. D. Langworthy, P. de Laszlo, T. P. Legg, Dr. A. M. McCutcheon, F. E. Marrack, P. B. Moodie, J. G. P. Phillips, Mrs. M. I. M. Potter, Mrs. Riddel, and J. W. Wilson were elected members.

The Institute of Metals.

No. I.

The annual general meeting of the Institute of Metals was held in London at the Institution of Mechanical Engineers, Storey's-gate, on Wednesday and Thursday, March 7th and 8th. The routine business of the annual general meeting on March 7th was presided over by Sir John Dewrance, who then inducted his successor, Dr. W. Rosenhain, F.R.S., into the chair.

At the outset Sir John called attention to the presence of Dr. Georg Masing, of Messrs. Siemens-Halske, Berlin, and representing the Deutsche Gesellschaft für Metallkunde and the Verein Deutsche Ingenieure, the former being the corresponding Institute in Germany of the Institute of Metals, and he called upon Dr. Masing to address the meeting.

Dr. Masing expressed the regret of Mr. Czochralski, President of the Deutsche Gesellschaft für Metallkunde, that he was unable to be present, and in the course of a short speech emphasised the need for the election of foreign members to institutes such as those he represented and the Institute of Metals and for the dissemination of scientific knowledge throughout the world. To that end there should be the fullest co-operation between such institutes, and his younger Institute would be willing to co-operate in the fullest possible manner with the Institute of Metals.

The President assured Dr. Masing that the Institute of Metals reciprocated the views which he had expressed, and at the same time gave a hearty welcome to Dr. Haas, of Germany, and several other foreign members who were present.

The annual report of the Council was then presented, and expression was given by the President to the hope that the membership would reach the 2000 mark this year. The work of the Corrosion Research Committee is fully dealt with in the report. A programme of work with the new apparatus for large-scale laboratory tests was started at the beginning of the year and has been proceeded with continuously. The tubes tested include various types of 70 : 30 brass and Admiralty alloy tubes, several compositions of cupro-nickel, and a few special alloy tubes. During the year a number of cases in connection with condensers of ships and power stations have been investigated and have given interesting information.

The Council is able to report that during the year it was found possible to carry out a scheme that had been projected for many years—but hitherto rendered impracticable owing to lack of funds—whereby the library might be enlarged and a full-time trained librarian appointed. The new library, which is well stocked with up-to-date metallurgical books and periodicals, has been placed under the charge of Miss E. B. Wynburne, B.A. It is hoped that the new arrangement, together with the provision of a telephone in the reading room, will enable still greater service to be afforded to members. Certain books that are not contained in the library can now be obtained on loan for the use of members from the Science Museum at South Kensington. This is a most valuable new facility. Members are reminded that they can borrow books or periodicals from the library by post. The full development of the library is still hampered by lack of funds, and the Council would welcome donations to the library fund or the gift of books. The Council reports that the long-needed expansions of the Institute's office accommodation was made possible during the year, an adjacent suite of rooms on two floors having become vacant. Thus the accommodation has been more than doubled. Illustrations issued with the report indicate how conveniently the Institute is now housed.

The report was unanimously adopted, as were the accounts which were presented by the Hon. Treasurer, Mr. John Fry, who called attention to the fact that the financial position as shown in the accounts for last year are the best yet presented. The credit balance of £546 was largely due to increased membership. It was obvious, however, said Mr. Fry, that the Institute would in future years have to face a budget of £3000, and increased revenue would have to be looked for owing to the necessary and continuing increase in the cost of the *Journal*. Out of the membership of 1900 at the present time, 700 were foreign members, and it seemed to him that Great Britain should do better than 1200. For an Institute of such importance the financial position was not strong enough, and he appealed to every member to do his best to introduce new members.

After cordial votes of thanks had been passed to the Hon. Treasurer and the Council, Secretary and staff, the Secretary announced that Dr. Walter Rosenhain, F.R.S., had been elected President for the coming year. It was also announced that since the last meeting of the Institute 112 new members had been elected. The auditors having been re-elected, Dr. Walter Rosenhain took the chair, and after a vote of thanks to Sir John Dewrance, the retiring President, delivered his presidential address, of which a long abstract is printed on other pages of this issue.

The vote of thanks was proposed by Mr. W. R. Barclay (Henry Wiggin and Co., Ltd., Birmingham), who said that the address constituted one of the most telling arguments in justification of the work of the Institute. Mr. H. B. Weeks seconded, and the vote of thanks having been carried with acclamation, the reading and discussion of papers was proceeded with.

The first paper was "The Deterioration of Lead Cable Sheathing by Cracking and its Prevention." We give below the author's summary.

THE DETERIORATION OF LEAD CABLE SHEATHING.

The phenomenon of the cracking of lead cable sheathing had received little attention until, recently, the problem was studied in America and Germany as well as in this country. The authors of the present paper have examined large numbers of cables with cracked sheaths, and have considered the positions in which they failed. The cracks were found to be intercrystalline, had commenced on the inside of the sheaths and were generally free from corrosion. The lead in the region of the cracks was not distorted.

Definite evidence was obtained that where lead sheathing failed by cracking, the cable was in a state of vibration. Alternating stress tests on lead and its alloys in the Haigh machine indicated that lead has a very low fatigue limit, and the fractures obtained in the pure lead test pieces were similar in all respects to those found in failed cable sheathing. The conclusion was, therefore, reached that the cracking is a fatigue type of failure.

The addition of other metals to lead greatly raised its fatigue limit, and amongst the most effective additions is cadmium. The properties of certain ternary lead alloys containing cadmium have been investigated, and their high fatigue limit (more than three times that of lead) and resistance to oxidation and corrosion, make them very suitable for cable sheathing which has to withstand vibration.

Explanations other than the above which have been advanced to account for the cracking have also been investigated. These included the presence of deterious impurities in the lead, overheating during working, abnormal grain size, allotropic change, intercrystalline corrosion and prolonged tensile stress. Of these only two, intercrystalline corrosion and prolonged stress, might cause intercrystalline cracking in lead, but cracks produced by the former are associated with much corrosion product, and by the latter with much deformation of the lead.

The discussion was opened by Capt. P. Dunsheath, chief of the research department of W. T. Henley's Telegraph Works Company, Ltd., who said the type of fatigue referred to in the paper has been going on for many years, and there had always been a great deal of discussion between cable makers and users as to the cause. The paper was an authoritative statement on the subject and would be most useful because hitherto the cable users had not appreciated the elementary facts of the case and always attributed the trouble to bad or impure lead. It was apparent from the paper, however, that the best of lead could not endure certain conditions likely to be imposed on a cable in operation. As regarded the test adopted by the author to determine the relative merits of various metals, using the Haigh testing machine, he himself had adopted an entirely different method in which, instead of working on the fatigue limit, he actually distorted the lead a given number of times and compared the number of distortions that were possible. He thought there were advantages in that method over the use of the Haigh testing machine. It had previously been used in America, and he would like to hear the author's view on the comparative merits of the two methods. In some respects the results secured followed closely those obtained by the authors, but in others there were differences. He felt, however, that there was an advantage in his method of testing, because it more closely approximated to working conditions, inasmuch as the lead had to go with the object to which it was fixed. If a cable were laid across a railway bridge it was not subjected to a certain stress and released, but it had to move with the bridge, and that condition was reproduced in the test he had mentioned.

Mr. F. O. Barralet (G.P.O. Research Station) thought the cable user hitherto had been a little bit ahead of the scientific investigator in that matter, inasmuch as lead cables had been in use for many years. It was, however, very comforting to find that authentic scientific data were now available to give confidence in the results that might be expected. Experiments carried out in America as long ago as 1909 by Dr. Jewett, and described before the American Institute of Electrical Engineers, demonstrated the superiority of the 1 per cent. and 3 per cent. tin alloy over pure lead. He was inclined to believe that the cracking referred to in the paper was related to cold shuts, although there were other causes. Photomicrographs showed that there was no proper interlocking of the lead crystals across the boundary, and that fact would probably lead to localisation of stresses if the cable was deformed a bit in the ducts in which it was laid or in actual transport.

Mr. H. C. Lancaster regarded the paper as of first importance to the cable industry, which used more lead than any other industry to-day. His view was that the cause of the cracking was the extreme stress from which the lead suffered. A simple example was that many thousands of tons of sheet lead were rolled and used every year, and although he did not suggest that none of it ever cracked the amount of cracking was extremely small. Rolled sheet lead was used in large quantities on the roofs of many thousands of buildings, and did not seriously crack; why, then, did it crack on cables? Surely the answer must be that by extrusion the lead was stressed in a totally different way from that it endured in rolling. For many years the Admiralty used to take rolled zinc angles, but one firm thought it would be easier to extrude them. The result, however, was absolutely hopeless, the extruded angles going to pieces very quickly. Having had considerable experience of chemical sheet lead of great purity, he was inclined to think that the demand for purity was something of a parrot cry, because in many cases in practice it was a grave mistake to use absolutely pure lead. All sorts of difficulties were encountered when using material of 99·995 per cent. purity, which could be obtained. Lead of that class had failed in cases where motors were running quite close to the chambers in chemical works, because of the vibration, which was bad. In cases where that class of lead had been turned into strip and fastened on to wood suspenders cracking had occurred, but it had been overcome in no small measure by introducing certain elements, such as copper. They slightly increased the tensile strength and the grain was reduced from a large one to a small one. Therefore it was likely that the cable makers, in striving after very pure lead, had run into these other difficulties from cracking.

Mr. Beckinsale, replying to the discussion, said the reason why he had adopted the Haigh testing machine was that he had examined a large number of cable failures and found no evidence of distortion of the lead; the trouble had evidently been due to the lead being bent up and down. He had known of cold shuts, as mentioned by Mr. Barralet, but reference to them in the paper had been purposely omitted. They were due to films of oxide and impurities in the lead and did cause trouble. As regarded Mr. Lancaster's remarks, it was possible that extruded metal might be in a state of internal stress, and it was possible that external factors, which had not been noticed at the time, might have entered; but, having found an alteration which improved the position, the authors had not looked any further for an explanation. Cable makers were realising that pure lead was not ideal for their work and that particular research had been largely financed by the cable companies. With an impure lead, however, there was the risk of corrosion trouble. Although it might not be very serious in a lead pipe, it was a very different matter with a cable. Hence the cable makers had to go very warily in selecting their lead in order that they should not land themselves in all sorts of troubles. The Non-Ferrous Metals Research Association should be able to give much information on that subject.

The annual dinner of the Institute was held at the Trocadero on Wednesday evening. The fact that it was more largely attended than ever before may be regarded as amongst the many indications of the progress of the Institute. The new President, Dr. Rosenhain, occupied the chair, and around him at the high table were many eminent guests. Mr. H. T. Tizard, in an admirable after-dinner speech, proposed the toast of "The Institute of Metals," coupling with it the name of the Chairman, and Dr. Rosenhain replied. The only other toast was that of "The Guests," which Mr. A. H. Munday proposed and which was gracefully acknowledged by Sir Richard Glazebrook and Mr. E. F. C. Trench, President of the Institution of Civil Engineers.

SIXTY YEARS AGO.

The development of the high-speed steam engine had yet to take place when we wrote on the subject in our issue of March 6th, 1868. We estimated that at that date there were probably not a dozen high-speed engines of any considerable power at work in this country. By high speed we meant anything from 150 to 400 revolutions per minute, but we were careful to point out that rotary speed was not a complete criterion and that high linear piston speed was the correct factor to consider. It would appear that there were a number of advocates of high speed among the engineers of the time, but that they had not so far succeeded in establishing their case. They had, we said, much to offer on the theoretical side, but on the practical side only one high-speed engine which promised to be successful had been produced. That engine was the Allen—presumably we referred to the Porter-Allen, an American engine—"one of the most elegant and refined conceptions of the brain that has ever been produced by a mechanical engineer." Even that engine, we said, had never displayed any unparalleled economy, and had, we believed, been beaten by the Corliss engine, an engine which could not compare with it for a moment as the production of refined mechanical talent. Where, we asked, was there evidence of engines running for months, day and night, at 250 revolutions and burning but 2 lb. of coal per horse-power, yet costing no more than a cumbrous machine of the ordinary type? It was quite possible, we believed, to build an engine to run successfully at speeds even as high as 300 or 400 revolutions. Such a machine, however, could not be classed as an ordinary engine. It was nothing more or less than a delicate mathematical instrument. It was quite unfitted for ordinary control, and could not be made by ordinary fitters operating ordinary machine tools. Appeals based on beauty of design or workmanship or on theory would fail to secure commercial success. Facts favourable to the practical performance of the high-speed engine could alone ensure its sale, and such facts were, we said, not so far available. We did not believe, as some did, in the impossibility of high speeds. On the contrary, we had persistently advocated their use within reasonable limits. We desired, however, to see the subject thoroughly discussed and the experience that had been accumulated up to date with high-speed engines publicly disclosed. So far as we can discover, our appeal for information produced no response.

The chairman of the Southern Railway announced at the annual meeting of the company on February 21st, that the claims made as a result of the Sevenoaks accident were being dealt with.

Railway Matters.

MR. JUSTICE SALTER has been nominated to the position of *ex-officio* Commissioner for England on the Railway and Canal Commission following the transfer of Mr. Justice Sankey to the Court of Appeal.

DESPITE the opening of the City and South London Extension to Morden, which took about 4,000,000 passengers a year from the Southern Railway, there was an increase of 7,250,000 passengers in the electrified area of the Southern Railway last year, as compared with 1925.

ANSWERING a question on February 21st as to the Coal Wagon and Transport Committee, Colonel Ashley said he understood that that body was still engaged in the collection and consideration of the data connected with the matters remitted to the Committee, but he was unable to say when a report would be made.

IN *The Times* of March 2nd there was a letter from that well-known authority on railway locomotive history, Mr. A. Rosling Bennett, wherein he pointed out that at the Cardiff meeting of the British Association in 1891, he read a paper, "An Electrical Parcel Exchange," which anticipates most of the novel features in the Post Office Tube Railway.

OWING to the provision by the London, Midland and Scottish Company, of colour light automatic signals on the two lines, out of four, between Campbell-road Junction and Barking that are fitted for electric traction and over which the trains of the Metropolitan District run, the long-promised increased train service of the latter company was brought into use on Monday last, March 5th.

THE Southern Railway Company has intimated, by a letter from the general manager to the season ticket holders, that, during the rush hours, the trains from Caterham and from Tadworth to Cannon-street and Charing Cross, cannot be taken beyond London Bridge, but will be turned into the low-level station there. The inconvenience is only temporary, and will be removed when the lines in question have been converted to electric traction. We would add that that work is now being pushed forward on the Tadworth line, as it is hoped to have electrically operated trains running to Tattenham Corner by next Derby Day.

IN this column of our issues of July 29th and October 28th last, mention was made of the gratifying success which had attended the efforts of the operating department of the Southern Railway to secure the punctuality of its trains. From the chairman's speech at the annual meeting last month we learn that the average for the 180,000 trains a month had been brought down to two minutes late. But the big storm at Christmas had upset everything, and they had never really got into their stride since. The abnormally wet weather of last summer and autumn caused more percolation of water into a number of tunnels than had been known in living memory.

THE Ministry of Transport railway statistics for November last, recently published as a Stationery Office publication, price 3s. 6d., show that, compared with November, 1925, there was the slight decrease of 0·2 per cent. in the number of passenger journeys. Actually, there were over 4,000,000 more passengers carried at reduced fares, but that was offset by a corresponding fall in the full fares. The consequent decrease in receipts from passengers was 3·6 per cent. Passenger train mileage increased by 5·5 per cent. The tonnage of freight traffic rose by 3·0 per cent., the receipts therefrom by 5·6 per cent., and the freight train miles also by 5·6 per cent. The average tain load fell, however, from 132 to 128 tons.

SPEAKING recently at the annual meetings of the companies which form the Underground group, Lord Ashfield said, as regards the proposed London traffic pool, that it was incorrect to assume that that scheme was theirs, though the scheme of the London and Home Counties Traffic Advisory Committee had borrowed certain features from the Underground pooling plan. Lord Ashfield added that he did not believe that a board of management or a managing committee could successfully manage from day to day the vast and complicated business of London traffic, and he made it very plain that the Underground group was not prepared to place the administration of its undertakings in the hands of any board or committee.

A GREATER use of what are now called steam rail cars was outlined in an interview Sir Ralph Wedgwood gave to a newspaper correspondent recently. Sir Ralph said that, after trials with the Sentinel-Cammel and the Clayton types, fifty steam rail cars were about to be ordered for use in the North-Eastern area. They are to be employed on services now given by ordinary steam trains. They have seating accommodation for sixty-five passengers and for twenty-eight standing. The principal economies to be effected are that only two men, instead of three, are required on the train, and the coal consumption is less than one-half; moreover, the cost of maintenance and renewal is very considerably reduced. The result, according to a leading railway authority, is that the total cost is about one-third that of an ordinary branch line passenger train service.

THE London and North-Eastern Railway has decided to abandon its Peak Forest tramway, and a keen controversy prevails in the Chapel-en-le-Frith neighbourhood as to whether or not the local authorities should purchase it and make a road in its place. It was one of the tramways that were built to supplement canals. The Peak Forest Canal lies between the Macclesfield and the Ashton canals and was sanctioned in 1794. A tramway was authorised by the same Act to run from the canal at a point which is now the Brigsworth Station of the L.M.S. Railway to Dove Holes. It is 6 miles in length and reaches an elevation 1139ft. above Ordnance Datum. Part of the ascent is done by an inclined plane, 520 yards long, on a gradient of 1 in 8½, with a short length near the top of 1 in 6½. The line was laid out by Outram, who placed plate rails, 3ft. in length and weighing 56 lb. per yard, on stone sleepers. About 1870 new rails were required, so the Manchester, Sheffield and Lincolnshire—which company acquired the canal and tramway in the 'forties—rolled new rails of the same section and weight, but 9ft. and 12ft. long, in the locomotive shops at Gorton.

Notes and Memoranda.

THE completion of the Avon dam has added 47,000. million gallons to the storage system of the Sydney water supply, so that the total is now nearly 100,000 million gallons. The daily consumption is about 65 million gallons.

AN article by Mr. J. C. Stevens in the *Engineering News-Record* of February 9th, gives some particulars and a drawing of a special form of overflow lip for thin arched dams, which has the effect of throwing the nappe of the overflow well clear of the toe of the dam, so that the foundations are not undermined. Provision is made for ventilating the space between the nappe and the dam to prevent vibration.

THE various forms of apparatus used for removing dissolved gases from water depend upon the use of heat and a vacuum, either separately or both at once. Those employing both heat and a vacuum are, says *Nature*, the most efficient, and a new apparatus of this type is described by Lorch, Williams, and Thompson in the *Journal* of the American Chemical Society for December, 1927. This apparatus is of simple construction and is adaptable to any amount of liquid or gas.

THE Board of the Suez Canal Company has decided that on and after April 1st the transit dues of the Canal will be reduced by 25 centimes. After that date transit dues will be 7f. per ton for vessels carrying cargo, and 4.50f. per ton for vessels in ballast. It is interesting to note that the prediction of de Lesseps, the builder of the Canal, that the traffic through the Panama Canal would ultimately exceed that of the Suez Canal was borne out in 1926, when vessels with a gross tonnage of 26,836,000 tons paid transit dues for taking the Panama route, as compared with vessels totalling 26,606,000 tons which passed through the Suez Canal.

A MESSAGE from Stockholm states that the Swedish engineer M. Tryggve Pehrsson, of Gothenburg, has invented an apparatus by which the temperature in a chamber may be automatically maintained at a fixed point. The principle of the invention is said to be quite new, but details cannot be made public as yet, since the question of a patent is not yet definitely settled. The apparatus can, it is said, be constructed for a wide range of temperatures, is not easily damaged by jolting, so that it can very well be used in railway coaches, for instance, and takes up little space. It is further stated that the running costs are very small, the electric current necessary to start the apparatus being only required for a moment.

THE comparative cost on the basis of B.Th.U. refrigerating effect between solid carbon dioxide and water-ice is, according to *Cold Storage*, approximately as follows: Water-ice per pound equals ·5 cents, CO_2 ice per pound equals 10·0 cents, hence water-ice equals $·5 \times 1·18 = ·59$ cents, as against up to 30 cents for CO_2 on the basis of 10 cents per pound. This cost is calculated on the assumption that the CO_2 is solidified in the refrigerator of the consumer. It may be considerably reduced when furnished in the solid form by liquid CO_2 manufacturers, who can produce it on a larger scale. However, the relative and comparative cost under the most favourable conditions will still be ten times greater than the cost for water-ice.

AN implied warning as to the wisdom of accepting steam fittings as being proper without individual inspection is contained in a recent explosion report. The accident happened on board ship, and was caused by water hammer. Fortunately no one was hurt. The inspector says:—"On examining the cock on the throttle valve, I found that the port in the plug measured ⅛in. by ¼in., but the port in the shell on the outlet or drain side was reduced by casting fins to an opening less than ⅛in. in diameter. At some time the operating handle on the cock had been broken off, a substitute handle fitted on to a square formed on the end of the plug, and a mark indicating the position of the port in the plug put on with a file. This mark had been incorrectly placed, with the result that when the mark was turned to the "open" position, the port was nearly blind in the shell and rendered the cock practically inoperative."

THE issue of the *Journal de Physique* for November contains a communication from MM. E. Henriot and E. Huguenard on the use of gaseous bearings for small motors and on the extremely high speeds of rotation which can be obtained in this way. The fixed part of the bearing is a vertical cone of semi-vertical angle about 60 deg. and 1 cm. side. Half-way down the side there are eight or ten holes up which air or carbonic acid gas at 2 to 6 atmospheres pressure is forced. The rotary part is coned underneath, the semi-vertical angle being about 65 deg., and the conical surface is provided with fine grooves along its generating lines. With a rotor of 1 cm. diameter a speed of 11,000 revolutions per second was obtained, and with it the Foucault measurement of the speed of light could be made with the reflecting mirror only 1 m. away. Rotors of 2·5 kilos. have been driven at 1100 revolutions per second. In all cases it is found desirable to mount the fixed part of the bearing so that a little side play is possible.

ACCORDING to the *Electrical West*, thirty-three additions were made to hydro-electric generating plants throughout the eleven Western States of America in 1927 and 1928. Eleven of the plants are listed as having been completed in 1927 and twenty-two are now under way or are planned for construction at an early date. Three installations, notable as high-head plants, have static heads of 2420ft., 2381ft. and 2561ft. respectively. Six other plants having heads exceeding 500ft. are listed, but not all Western developments are in the high-head class, as several with heads below 50ft. are included, one of 3000 H.P. capacity being designed for a head of only 16ft. The first propeller type runners to be installed in the West were put into service in 1927 at the Black Eagle plant in Montana and two notable automatic plants are listed in British Columbia rated at 12,500 and 17,500 H.P. respectively. The largest units are double overhung impulse turbines to develop 56,000 H.P. under a head (static) of 2420ft., and a reaction unit of notable size and head is the 44,000 H.P. turbine to be built this year for a head of 715ft. (static). Installations of less than 1000 H.P. are not included.

Miscellanea.

THE Pretoria Town Council has decided to order a 7500-kW turbo-alternator.

THE total production of magnesite in India during 1926 created a record with 30,461 tons.

A COMPANY has been formed in Sweden for the manufacture of printer's ink from sulphite lye according to the process of M. Ludvigen.

TWO plants for the distillation of oil from coal by the Dvorkovitz process are to be put up in Australia by the National Carbonisation Syndicate.

A MILL for rolling black sheets in Japan has been ordered from the Tobata Casting Company by Mr. Etsujiro Nakayama. It will have an output of 15,000 tons a year.

A PIECE of land adjoining the Great West Road and the river Brent has been acquired by the Firestone Company of America, for the establishment of a rubber tire factory.

A BEET sugar factory is to be put up at Brigg, Lincolnshire, at a cost of £300,000. The contractors are Sir Robert McAlpine and Sons, and the capacity of the plant is to be 700 tons a day.

ARRANGEMENTS have been made for the construction of an aluminium factory in Italy. The Haglund process is to be used. The name of the company is the Societa Italiano del Aluminio, Milan.

H.M. GOVERNMENT has appointed a Committee, consisting of members of the Ministry of Health, the Home Office, and the Medical Research Council, to inquire into the distribution of ethyl petrol.

CONTRACTS have been awarded for a power development project of 65,000 H.P. on the Back River, or Rivière des Prairies, seven miles from Montreal. The total value of the works, including dams and equipment, will be about 8,000,000 dollars.

AN interesting feature of the Machine Tool and Engineering Exhibition to be held at Olympia from September 5th to 22nd next will be a display of machines of historical interest, among which will be included a lathe made 120 years ago by the famous Henry Maudslay.

A CONTRACT has been received by W. T. Henley's Telegraph Works Company, Ltd., for a high-tension feeder in the form of underground cables and overhead lines to supply the towns of Saxmundham, Wickham Market, Melton, Orford and Hollesley from the Ipswich mains.

AMONG the electric lighting schemes in contemplation, or recently put into operation in the State of Hyderabad, there is that at Arangabad City, which has a capacity of 280 kVA, and is equipped with Mirrlees Diesel engines with Metrovick alternators. There are also schemes for Raichur, Warangal and Jalna, which, it is estimated, will cost at least 20 lakhs of rupees.

A NEW monthly publication of interest to all concerned in building construction and allied subjects will be placed on sale shortly by H.M. Stationery Office. Its purpose is to provide, for the building industry, up-to-date summaries of the latest developments in the science and practice of building which are taking place throughout the world. The price of the publication is to be 9d. monthly.

THE two double-cylinder 25,000-kilowatt turbo-generators needed for the Kirkstall station of the Leeds Corporation are to be supplied by the British Thomson-Houston Company, of Rugby. The machines are rated at 35,714 kVA 10,500/11,500 volts, three-phase, 50-cycles, and the turbines are designed for a working steam pressure of 450 lb. per square inch gauge at 750 deg. Fah. temperature.

THE Marlborough (New Zealand) Power Board has, according to the *Industrial Australian*, recently put into operation its hydro-electric power station at Benopai on the river Waihopai. The site permits of a development of 1900 H.P. and the plant installed includes two Francis type turbines, each driving a 500-kW 6600-volt alternator. Electricity is transmitted to Blenheim at a pressure of 33,000 volts.

THE nitrogen fixation factory in Patsch belonging to the Luftverwertungs Gesellschaft, of Innsbruck, has, according to the *Chemical Trade Journal*, been closed down. The plant, which manufactured nitric acid and sodium nitrite, utilises the arc process and has been in operation for nearly twenty years. It was originally founded to utilise the excess current of the town of Innsbruck, but this current is no longer available at economic prices.

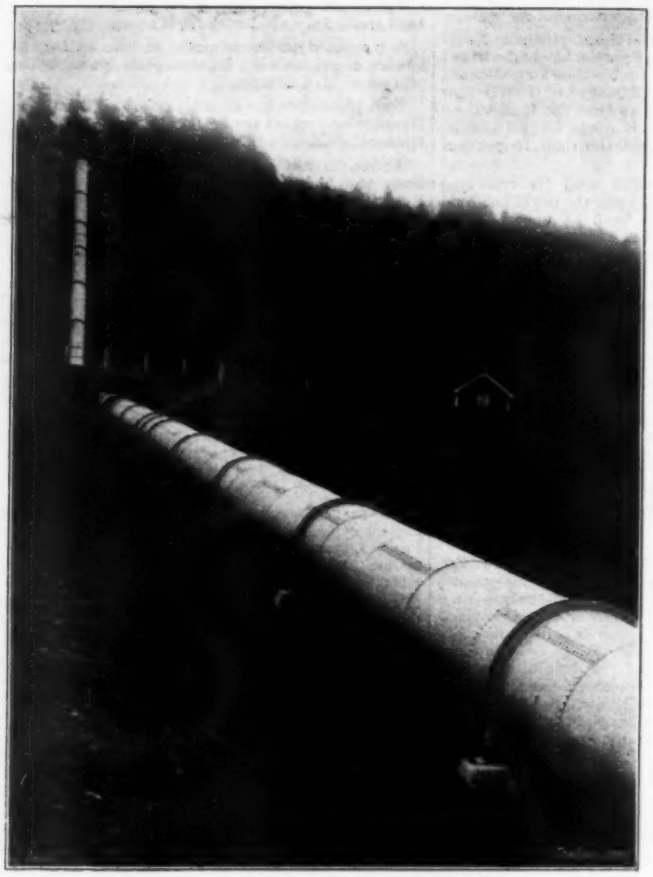
CONTRACTS have just been let for over two miles of concrete pipe to be used in connection with the Southampton Docks Extension scheme. These pipes will be 7ft. in diameter and will be embedded in concrete culverts and laid under the tidal mudlands. Apart from the materials required in the pipes themselves, the culverts will require some 50,000 tons of gravel and 7000 tons of cement. Work is to be begun immediately, and will take about eighteen months to complete.

ACCORDING to a recent announcement the well-known Swedish Fagersta Iron and Steel Works have acquired the licence for the Flodin-Gustafsson process of producing malleable steel directly from iron ore concentrate. This process, which is carried out in special electrical furnaces, where the iron concentrate is mixed with pulverised coal and certain other substances, will now be practically tested by the Fagersta Company, but previous tests made at the Uddeholm Works are reported to have yielded good results.

CONTRACTS have been given out to French shipyards for four submarines of 630 tons displacement, each fitted with two Diesel engines of 600 horse-power, all of them Normand engines except for the submarine to be constructed by Schneider and Cie., who will fit their own engines. Four cruising submarines of the "Redoubtable" type, with a displacement on the surface of 1560 tons, have been ordered from the Chantiers Navals Français, the Forges et Chantiers de la Mediterranée, the Chantiers Dubigeon and the Chantiers de la Loire. They will all be equipped with two Sulzer engines, each of 3000 horse-power.

RÖTTLE HYDRO-ELECTRIC POWER STATION, SWEDEN

(*For description see page* 258)



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THE ENGINEER.

MARCH 9, 1928.

Automatic Sub-Stations.

OF the many things that have been evolved for the purpose of saving labour few have called for more skill and ingenuity than automatic sub-stations. When it is remembered that rotary converters are synchronous machines that must be brought into phase with the alternating-current supply; that there must be no possibility of connecting them to the direct-current bus-bars with incorrect polarity; that heavy overloads and short circuits have to be grappled with; and that mechanical and electrical faults may arise, it is seen that in designing sub-stations which can take care of themselves electrical engineers have mastered a task presenting considerable difficulties. But the equipment of an automatic sub-station is, of course, more costly and more complicated than that of a manually operated one, and it is somewhat expensive to maintain. Dealing with this matter in a paper on "Some Practical Considerations in the Design of Automatic Equipment for Heavy Traction Sub-stations," read before the Institution of Electrical Engineers, Mr. H. B. Poynder says that minor adjustments which are carried out by the attendants in a manually operated sub-station become serious items of expense in an automatic station. The designer's aim should therefore be to reduce the frequency and duration of the visits of the maintenance staff to the absolute minimum, even if departures from existing arrangements are thereby necessitated. The flashing that takes place at the brushes of rotary converters when short circuits occur has been one of the main difficulties associated with automatic operation, and even now the author appears to consider that in order to ensure satisfactory operation on 1500-volt systems it is advisable to connect two 750-volt machines in series. Even in the absence of high-speed circuit breakers, machines operated in this way are capable of dealing with short circuits close to the sub-station, for although heavy flashing occurs it does not damage the commutator and brush gear sufficiently to affect the operation to any appreciable extent. The instantaneous energy comes from the inertia of the armature and not from the alternating-current supply, so that during the time the short circuit lasts the armature has an angular displacement, although it does not in general slip a pole. The use of high-speed circuit breakers has had a distinctly beneficial effect on rotary converters subject to short circuits, more particularly because they limit the duration of the flashing and the total volume of vapour produced. Perhaps the most revolutionary suggestion made by Mr. Poynder is to replace the orthodox horizontal rotary converters by vertical machines, a scheme that appears to be well worthy of consideration where space is limited.

The first automatically controlled sub-station put into operation in this country was described by Mr. P. J. Robinson in a paper read before the Institution of Electrical Engineers in 1923. Since that time other equipments have been put into service both on traction and general supply systems, but although certain improvement may have been made in the design, the complexity of automatic control gear has not been appreciably reduced; in fact, the tendency appears to be to add additional gear. We find in Mr. Poynder's paper, for example, a suggestion for reducing fire risk, involving the use of selenium cells. Every additional piece of apparatus, however, adds to the cost and complication and tends to increase the maintenance cost, which is apparently what Mr. Poynder is anxious to diminish. While some engineers believe that it is good practice to guard against every possible fault, others maintain that protection can be carried too far. Automatic rotary converter sub-stations are not very common on the Continent, but we understand that those that exist are less complicated than stations designed by British engineers. The possibility of certain faults developing, such as hot bearing, for example, is considered to be so remote that no attempt is made to provide gear for dealing with them. We have often wondered if all the complicated paraphernalia to be found in automatic sub-stations will survive. The ingenuity of British electrical engineers is at least equal to that of those in other parts of the world, but it does not always seem to be realised that something entirely new is occasionally required. Rather than abandon an old fundamental idea, our electrical manufacturers will go to no end of trouble to make it meet present-day requirements, even if it involves considerable complication. The automatic rotary converter sub-station, which was originally an American idea, is an example of the adaptation of an old and well-tried scheme to present-day requirements. Mainly in order to reduce the high cost of labour complicated and expensive control gear has been brought into use, whilst the possibility of employing something quite different, or of eliminating converting plant altogether on extensive electrification schemes has been ignored. Anyone who imagines that the best possible method of obtaining 1500-volt direct current for railways is to connect two automatically controlled rotary converters in series must indeed lack imagination. In all places where conversion is indulged in, irrespective of whether it be for traction or general electricity supplies, or whether manually or automatically operated sub-stations are employed, it adds to the distribution expenses. Sir John Snell has published figures which show what conversion adds to the cost of current, whilst in a paper on "The Design of City Distribution Systems and the Problem of Standardisation," read before the Institution of Electrical Engineers in 1926, Messrs. Beard and Haldane stated that the expensive converting plant required with the direct-current three-wire system increases the overall distribution costs from 20 to 40 per cent., depending on the load density, even after making full allowance for the saving in labour charges effected by the modern automatically operated sub-station. Alternating current meets the needs of ordinary electricity consumers just as well, if not better, than direct current, except for a very few special types of motor drives. For railway work British engineers consider direct current to be the best. To provide this current automatically controlled rotary converter sub-stations are being advocated and tried, but the mercury vapour rectifier, which would appear to lend itself rather more readily to automatic operation than rotary converters, has not as yet aroused any enthusiasm in British electrical circles. A perusal of Mr. Poynder's paper will show that some of the difficulties associated with the design of automatic sub-stations would diminish if rectifiers were used. While it is apparently considered, by this authority at any rate, that for 1500-volt systems two rotaries should be connected

in series, there is no difficulty in building single rectifiers for 1500 volts or more. Rectifiers are apparently capable of dealing with heavy short circuits without detrimental effects and, needless to say, they do not have to be synchronised before they can be connected to the alternating-current supply. As a rectifier is a static piece of apparatus it is not likely to get out of order.

Some, at any rate, of the equipment that is essential in an automatically controlled rotary converter sub-station is unnecessary in an automatic rectifier station. Troubles with rectifiers have, of course, been experienced, just as troubles were met with when rotary converters were first introduced, but judging from what appears from time to time in various continental publications, the rectifier is making headway. One firm alone claims to have installed 1102 rectifiers with a total capacity of 562,485 kW. In neglecting the large-power rectifier, more particularly for 1500-volt direct-current traction schemes, British manufacturers are, perhaps, missing a good opportunity. It seems an extraordinary thing that in addition to all the machinery in power stations it should still be considered essential to employ machinery in sub-stations as well. That rectifiers are not cheap we are well aware, but it does not follow that their cost will never be reduced. Research and experience in manufacture may easily result in improvements in price and in operation. The reduction of complication is, to our mind, desirable, even if it does not result in any appreciable saving in money. It is difficult to believe, however, that a 1500-volt automatically controlled rectifier would not prove cheaper and better than two series connected converters. Much has been said of late about the inexpensive continental methods of distribution for general electricity supplies, but no one seems to have observed that on a large section of the Continent the railway distribution systems are also cheap and that, for the most part, rotary converter sub-stations do not exist. That it can be shown that automatic sub-stations are advantageous from a financial point of view we do not doubt. The point to be considered, however, is whether the adoption of a different scheme would not prove more beneficial, and incidentally remove some of the existing complications.

The Railway Meetings.

WHILST 1927 was, of course, less disastrous for British railways than its predecessor, which saw the general strike and a coal stoppage that lasted for over six months, it was a somewhat disappointing year. The aftermath of the coal stoppage was felt in all the industrial areas, as the people's savings had been exhausted and there was less to spend. Sir Josiah Stamp said, on that point, at the London, Midland and Scottish meeting, that at places like Bolton, Huddersfield, Wigan and Sheffield the bookings declined by 10 per cent. The abnormally bad weather in the summer and autumn added to the misfortunes, and on the top of those troubles the railways had to contend with severe competition from road transport. The net result was that, when compared with the normal year of 1925, the four grouped companies carried, we find, 8 per cent. fewer passengers and took 6 per cent. less passenger receipts. Fortunately, the takings from goods traffic were, on the other hand, better, and so the London and North-Eastern and the Great Western closed the year with something in hand; the London, Midland and Scottish made, however, a slight loss, and the Southern was 2 per cent. to the bad. But when the expenditure is considered greater cause for satisfaction can be found. In THE ENGINEER of April 29th last we endeavoured to show how the engineers and operating officers of British railways rose to the occasion during the misfortunes of 1926 and reduced their expenditure to suit the growing loss. The same tale can almost be told of last year. On another page of the present issue we have summarised the results for last year of the four grouped companies and compared them with those of 1925 as well as of 1926. We have, moreover, gone further and worked out some comparisons between 1927 and 1925, which cannot but be instructive to all and certainly complimentary to railway engineers. In the maintenance and renewal of way and works there have been great reductions, resulting, no doubt, from the war arrears having been overtaken and normal expenditure only being now necessary. Rolling stock charges are not as satisfactory, but it must be remembered that in 1925 large sums were taken from reserves, whereas in 1927 payments were made to reserves in order to replenish such funds.

In many directions the present year opens more hopefully. Engineers may find satisfaction in what their profession is doing on the London, Midland and Scottish, for instance. Sir Josiah Stamp said that owing to the introduction of modernised appliances and methods the equipment of the company's shops had so improved that at the end of 1927 the proportion of stock under or awaiting repair was the lowest since the company was formed. In 1925 the locomotives in the repair shops were 13·47 per cent. of the whole; at the end of 1927 they were 8·66 per cent. That decrease represented a gain of 500 locomotives in service. In building one particular type of vehicle improved manufacturing methods had brought down the costs by 30 per cent. The advantages, to the company and to the workmen, of the improved methods introduced in the Crewe works had exceeded their expectations. The new type of engine, exemplified in the "Royal Scot," allowed for non-stop runs between Euston and Carlisle and three locomotives of that type now do the work for which formerly eight of other types were required. Signalling also is producing great economies. We have more than once quoted a statement of the assistant chief general manager of the London and North-Eastern Railway that, by improvements in signalling, that company had been able to close seventy-eight signal-boxes and thereby to save £33,000 a year. Now, according to Mr. Whitelaw, at the annual meeting last Friday, that sum has become the noble one of £415,000 a year. The Southern, too, is saving money by the installation of modernised signalling. The light signal system and the power operation of points in the London area will cost £485,000, but it will allow seventeen signal-boxes to be closed and £19,000 a year to be saved thereby. It, moreover, will add to the safety of the line, increase the traffic capacity, and postpone widenings. The car retarders that are to be provided in the Whitemoor yard of the London and North-Eastern are expected to produce economy in working, as with their help it will become possible to speed up the movement of the wagons. Furthermore, they will reduce the damage to the contents of wagons now inseparable from ordinary gravitational shunting, will require fewer shunters, and will decrease the risk of accident to those men. Then in another direction is economy in operation forthcoming. It is in the use of steam rail cars on branch lines. These, we believe, can be worked at a little more than one-third of the cost of an ordinary steam train on a branch line. Mr. Whitelaw said that his company felt justified in purchasing a considerable number with a view to meeting the demand for a much more frequent service in certain districts. Both he and Sir Josiah Stamp have, also, great hopes from the extensive excursion facilities they are providing with, to quote the latter, "attractive inclusive bookings for meals *en route*." The crowds which have taken advantage of those facilities have demonstrated how widespread is the desire to travel. That being so it is the business of the companies to provide such facilities as the people reasonably demand. The policy must be carried out, though with discrimination, so as to bring new traffic and not to damage that already existing.

One of the brightest grounds for hope in the immediate future of British railways, and one that, possibly, will bring more present and permanent good than the granting of the much-desired road transport powers, is the happier relations that now exist between the companies and their staff. That matter was referred to by both Sir Josiah and Mr. Whitelaw. The former said that the events of the last two years had brought a clearer realisation to the railwayman that the very maintenance and existence of his position are involved in the prosperity of the railways as a whole, and that that prosperity can be materially affected by his own attitude towards it. It cut both ways, however. Those for whom the railwayman worked also realised that workers in the humblest positions may have a fund of knowledge, influence and initiative which, in the aggregate, are of the greatest value to the concern. In that work the companies, as said by the L.M.S. chairman, would acknowledge the attitude of the trades unions and the wise counsel they had given to the men. Mr. Whitelaw's remarks were of a very grateful character. He said that it was very gratifying to be able to record that the relations with the staff were exceedingly satisfactory and that the men had thrown themselves willingly into schemes for improved economy and efficiency which might, not so long ago, have been regarded by the staff from a less favourable angle. He hoped and believed that that state of affairs would continue, and so far as the company was concerned it would be its constant effort to maintain it.

Levelling with an Aneroid.

By Colonel Sir GORDON HEARN, C.I.E., D.S.O., Royal Engineers (Retired).

No. I.

THE use of an aneroid barometer for obtaining differences of level is regarded by many engineers as thoroughly untrustworthy. Nevertheless, this instrument, in the form of an altimeter, is used every day in aeroplanes, and the height records, given from time to time in the Press, are obtained by calculation from the chart of a self-recording aneroid. It is true that the result is only approximately accurate, and that no "record" is accepted unless previous heights attained are exceeded by some hundreds of feet. It is necessary to accept results obtained in ground levelling also as only approximately accurate. But, with care, quite good results can be obtained, provided the factors are thoroughly understood, and care is taken to eliminate errors as much as possible.

Sometimes travellers, provided with a good aneroid, announce that they have climbed mountains to a height of so many thousands and hundreds of feet, as shown by the feet-scale on the instrument. It is quite possible that the height is wrong by as much as a thousand feet. The barometer may vary as much as 2in. in England, between a reading in fine weather in summer and another in bad weather in winter. The only possible way in which to get good results is to work by differential levelling, from results obtained by observation at comparatively short intervals, and corrected, as will be discussed later. In this way some quite accurate work can be done. An account of the method was given in the "Railway Engineer's Fieldbook," in 1913, but the writer has now somewhat modified his practice.

In 1913 he was carrying out a reconnaissance for a railway on the North-West Frontier of India in mountainous country. The work had to be done rapidly, both because the distances to be traversed in the time available were great, and because the country was not safe, being infested by outlaws. One of the routes lay through a narrow defile, the course of a stream, which had cut through a limestone mountain. This defile had to be examined from each end, it being impossible to take transport through it for several reasons, and therefore about a month elapsed before the levels could be joined up. In the succeeding year the levels were run by spirit level, and it was reported that the aneroid levelling was substantially accurate. Yet it was carried out in the stormy winter, and the writer well remembers a miserable day passed in a small tent, with rain and snow falling outside, with smoke from green wood smouldering inside, and a howling gale shaking the tent. But all the while the aneroid was being watched with streaming eyes, and the record was being plotted so that the variations could be applied to the next day's work.

Years afterwards, the writer reconnoitred the Khyber Pass, between India and Afghanistan, for the railway completed in 1925. It was May and the weather was very hot. The general plan of the route had been formed in his mind, but the orders for the survey hung fire, and were then cancelled, for an armistice with Afghanistan had been arranged. However, the writer, determined to take some aneroid observations to test the feasibility of his plan, took a motor car and completed them in a few hours. One of his results turned out absolutely correct, when compared with subsequent spirit levelling, and all were reasonably close. Two quite inaccessible points were observed by clinometer from a spot, the level of which was obtained by aneroid near the road, and these two controlling points proved to be at levels, subsequently verified, and making the alignment possible. Levels high above the road in the precipitous Ali Masjid gorge were obtained in a similar manner, and, when the writer was asked a month later if the railway was feasible, he was able to give this assurance, based on the work of a few hours. These two instances show that levelling with an aneroid is better than a guess, but experience and care in its use are essential.

The aneroid barometer is a pressure gauge. The mercury barometer also is a pressure gauge, and in some ways more reliable, but for the engineer it is a cumbrous and awkward instrument to carry about. The pressure of the atmosphere is balanced by the weight of a column of mercury, but the top of the column is liable to be curved by capillary action where the mercury is in contact with the glass tube, the weight of the column is affected by a difference in the force of gravity varying with latitude and altitude, and the length of the column is affected by expansion varying with the temperature. Consequently, to every reading a number of corrections must be made before the true pressure can be calculated, and

before an estimate of the height corresponding to that pressure can be made.

In the aneroid pressure gauge the mercury column is replaced by a chamber, usually of aluminium, corrugated for greater strength, and exhausted of air. The expansion and contraction of this chamber is communicated by a chain to a pinion carrying a needle which records the pressure on a circular dial, graduated to inches, or in some forms of aneroid to feet of altitude corresponding to pressure. But, as will be seen, these graduations to feet are not reliable initially and have to be corrected for each observation. The instrument is sensitive to changes of temperature, as all metal instruments must be, but makers endeavour to eliminate such errors by some form of compensation, and no instrument should be bought which does not bear the word "Compensated" on the face of the dial. Makers ought to go a step further and mark the range of temperature through which the compensation is effective, for some aneroids are compensated from 32 deg. Fah. to, say, 95 deg. Fah., and others are compensated from 50 deg. Fah. upwards. It is necessary to know the temperature at graduation in order to apply the appropriate corrections, particularly if the aneroid is graduated in feet, for the altitude scale depends on the temperature at which it is calculated, and this also should be shown on the face.

Altimeters for aeroplanes have a device for giving equal space to each thousand feet of elevation, but this has nothing to do with compensation for temperature.

Some engineers are led to believe that the word "Compensated" means that at any temperature the feet scale is absolute. This is a great mistake, as will appear later in the examination of the theory. But a little reflection will show that, if the feet scale is fixed, a depression passing over will cause an entirely wrong estimation of the height. If the graduation in feet is made on a ring which can be rotated, and the zero mark be aligned with the point of the needle, the altitude scale will be found to measure more in inches for the first thousand feet than for the second, and to decrease in length for each successive thousand feet. The graduation having been made at a given temperature commencing from mean sea level at a normal pressure, usually about 30in., variations in the seasonal pressure and the temperature will vitiate the altitude scale engraved. If the commencing level be greater than mean sea level, the values cannot be correct. Hence it is recommended that a barometer engraved with a pressure scale in inches should be purchased, and even this is not entirely satisfactory.

Sir John Herschel, in an article contributed to the "Encyclopædia Britannica," and subsequently reprinted as a book, "Meteorology," mentions the observation of permanent depressions of the barometer in the Antarctic Ocean and in the Sea of Azov amounting to over an inch, so that at sea level the barometer indicates a height of 800ft. or more. Sir James Ross, during the voyage of the "Erebus" and the "Terror," found mean pressures, varying with latitudes at sea level between the Equator and 74 deg. South latitude. The writer has observed that aneroids in India, even within the limits of temperature covered by the compensation, show somewhat lower pressures than those shown by mercury barometers. Apart from this, the mean height of the barometer varies from month to month, between winter and summer, as will be shown. Since the difference of altitude, due to an inch of change of pressure from 30in. to 29in. is greater than the difference due to a fall from 27in. to 26in., this introduces a chance of error in any event, but utterly vitiates a fixed or movable feet scale.

It is necessary, therefore, when purchasing an aneroid for work between certain altitudes, to allow for an inch or so on either side of the pressures anticipated between these altitudes, so as to allow for vagaries of the instrument and for seasonal variations of mean pressure. This will affect the size of the instrument, and another factor affecting the size will be the "openness" of the scale, which should certainly be graduated to $^1/_{100}$in., and read by estimation to one-half of this fraction. Some prefer to use a smaller aneroid and to use a magnifying glass, but it is difficult to get the proper alignment between scale needle and eye. A vernier is useless.

The following is a specification of an aneroid, chosen by the writer and presented to him by the Institution of Civil Engineers as the Crampton Prize. The Watkin barometer was invented by Major Watkin (R.E.), and, besides improvements, included a means of detaching the contact between the recording needle and the pressure chamber, and of establishing contact at the moment of reading. This was intended to leave the pressure chamber as free as possible to expand and contract between readings, but the writer has had doubts whether in practice the establishment of contact does not bring an extra pressure to bear on the chamber, and has observed this. Therefore this feature was omitted.

Specification.—Watkin three-circle pattern, 4½in., in aluminium case, ranging from 21in. to 31in., without altitude scale of feet, with index hand on glass, dial divided to ·01in. and figured 10ths and inches. Compensated for temperatures between 32 deg. and 100 deg. Fah., and graduated for 32 deg. Fah.

Of course, workshop and testing laboratory temperatures cannot be reduced to 32 deg. Fah., and therefore allowance is made for temperature when marking off points on the scale for subsequent subdivision.

A necessary complement to an aneroid for surveying purposes is a thermometer, which should be in an insulated wooden case, so as to avoid vitiation of readings due to heating of a metal container, and also delays in waiting for the thermometer to adapt itself to the air temperature. Obviously it should be read in the shade. In order to obtain a quicker adaptation to the air temperature, the thermometer may have a loop formed at the top, through which a string can be passed and the instrument swung round, but this is rather a dangerous procedure, and a breakage may be most embarassing, if a duplicate is not at hand. A maximum and a minimum thermometer also should be obtained, for reasons which will be explained. Such thermometers seem always to have index errors, and not to agree.

A small book of section paper should be made up for plotting the continuous readings, which must be taken while the instrument is at rest in camp. Only thus can corrections be made for variations from day to day, due to storms passing over, or to the diurnal wave, which may have a considerable range in the Tropics. The time scale in the record should be an open one, say, $^2/_{10}$in. to an hour.

The National Physical Laboratory at Teddington undertakes the testing of aneroids, and issues what are still described as "Kew" certificates of their relative accuracy. A monogram is etched on the glass or engraved on the metal of instruments awarded this certificate. The test should be understood, and the following description is taken from the back of a certificate.

Temperature Test.—Test at 35 deg., 60 deg. and 95 deg. Fah. in suspended position at atmospheric pressures. Reject if difference of readings at any two of these temperatures exceeds 0·05in. (NOTE.—This is a considerable error, equivalent to perhaps 50ft.)

Test for Scale Errors.—Test at every inch from 31in. to 26in., with pressure diminishing from 30in. to 26in., and with pressure rising from 30in. to 31in., according to scheme (at the rate of 1in. in about five minutes). Twenty-four hours to elapse between the two parts of this test. Reject if the error at any one point in the first part of this test differs from that at 30in. by more than 0·04in., or if in any one inch there appears an error of more than 0·03in.

Test for Return (Creep or After Effect).—In the first part of the last-mentioned test, after keeping the pressure at 26in. for five minutes, allow it to rise to 30in. at the rate of 1in. in five minutes. Reject if the sum of the differences at 30in., 29in., 28in., 27in and 26in., with pressure diminishing and increasing, exceeds 0·15in.

The last two tests are, of course, carried out in the vessel of a vacuum pump, and the test is sufficiently severe, for it is practically impossible in ground surveying to carry the barometer up through a height of 1000ft. or so, represented by 1in. of pressure, in five minutes. The same applies to the matter of creep, although it may be advisable to allow in reading a very little more for increasing pressures. In the "Dictionary of Applied Physics" this phenomenon is attributed to strain of the metal in the works of the barometer, and diagrams show that much depends on the rapidity of change of pressure.

Most instruments show a marked difference if read first in a horizontal, and then in a vertical position of the face. They should invariably be read in the horizontal position.

The estimation of heights from pressures observed will be dealt with in a succeeding article, but it is necessary to record at each observation the position of the station, the time of each observation—on arrival and departure—the temperatures at times of each observation, with notes of the weather conditions, especially if rain falls.

(To be continued.)

Literature.

Jane's All the World's Aircraft. Compiled and edited by C. G. GREY and LEONARD BRIDGMAN. London: Sampson Low, Marston and Co., Ltd. Price £2 2s. net.

IT is a little startling to realise, as Mr. Grey reminds us in his preface, that the young men and women of to-day cannot remember a time when there were no aeroplanes. It is not yesterday but nearly nineteen years ago since the people of this country were aroused to the reality of artificial flight by Blériot's successful crossing of the English Channel. It is not yesterday, but some seventeen years ago since we received and reviewed the first modest volume in which the late Fred T. Jane sought to do for aircraft what he had already succeeded in doing for naval vessels. With the passage of time aeronautics has progressed out of all recognition, and Jane's "Aircraft" has progressed with it. The book has now reached a monumental form. This year's edition contains over 500 pages, and it is evident that even so it has been brought within that compass only by a process of severe pruning and the elimination of all matter relating to machines and engines of an obsolete and even obsolescent form. The amount of information contained in the volume is immense, as may be judged from the fact that it is sought to give the leading particulars together with photographs, and, in some cases, scale drawings, of all the aircraft types in the world. In addition there is a very full "Historical Section," in which notes are given on the year's work of each nation in military, naval and civil aviation. Much of the information is of an official or semi-official character, the only outstanding exception being in the case of France, which preserves exceptional secrecy in these matters, a secrecy which, in Mr. Grey's words, has compelled the editors to obtain the information desired elsewhere. It may be added that in spite of the disadvantages which they have suffered from the lack of official co-operation or assistance, the editors have succeeded in giving a very detailed account of the organisation and equipment of the French naval and military aviation services.

The book concludes with an excellent account of the world's aeronautical engines and with a brief section devoted to the world's airships. As a work of reference to current aeronautical activities, the volume occupies a really unique place in the world's literature. It is of value not only during the year of its currency, but long afterwards as a record of aeronautical history.

BOOKS RECEIVED.

Wärmedurchgang bei einfachen Körpern und Maschinen. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 8 marks net.

The Journal of the Iron and Steel Institute. Vol. CXVI. Edited by G. C. Lloyd. London: The Iron and Steel Institute, 28, Victoria-street, S.W. 1.

Werkstoff-und Bauvorschriften für Landdampfkessel nebst Erläuterungen. Berlin, S. 14: Beuth-Verlag G.m.b.H., Dresdenerstrasse 97. Price 3·50 marks.

B.O.T. Orals and Marine Engineering Knowledge: Steam and Oil. Fourth edition. By W. C. Macgibbon. Glasgow: James Munro and Co., Ltd. Price 30s. net.

England's Industrie am Scheidewege. By Professor Dr.-Ing. W. Müller. Berlin: V.D.I. Verlag, G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 7·65 marks net.

Statische und dynamische Untersuchung von Mündungsdampfmengenmessern. By Dr.-Ing. S. Kreuzer. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 4 marks net.

Locomotive Management: From Driving to Cleaning. Sixth edition. By J. T. Hodgson and the late J. Williams. London: The *Railway Engineer*, 33, Tothill-street, S.W. 1. Price 5s. net.

New South Wales: Thirty-ninth Report of the Metropolitan Water, Sewerage and Drainage Board, for the Year ended 30th June, 1927. Sydney: Alfred James Kent, Government Printer. 1927. Price 4s.

Die Grundlagen für den Bau und die Einrichtung von Lokomotivausbesserungswerken. By Dr.-Ing. F. Neesen. Berlin, W. 66: Verlag der Verkehrswissenschaftlichen Lehrmittelgesellschaft m.b.H., Beuthstrasse 8. Price 10 marks.

Obituary.

W. R. SEWARD.

IT is with very deep regret that we have to announce the death, following an operation, of Mr. William R. Seward. For many years Mr. Seward occupied an important position in the firm of John I. Thornycroft and Co., Ltd., by whom his loss will be very greatly felt. Mr. Seward was imbued with unfailing energy, determination and remarkable foresight, whilst he will always be remembered for his tact and courtesy by those with whom he came in contact.

WILLIAM WINSON HALDANE GEE.

THE death took place, on the 3rd inst., of Professor W. W. H. Gee, at his home, Oaklee, Sale, in his seventy-first year. Professor Gee was born in Bolton and was educated at the Manchester Grammar School, the Royal College of Science, and Owens College, and graduated B.Sc. at London and M.Sc. Tech. at Manchester. In 1902 he was appointed Professor of Pure and Applied Physics at the Manchester College of Technology, after being chief lecturer in physics and electrical engineering at the Manchester Municipal Technical School since 1891. Professor Gee was largely responsible for the design and equipment of the laboratories, &c., in physics, electrical engineering and electro-chemistry at the Manchester College of Technology, and was honorary curator of the Manchester Literary and Philosophical Society. He retired from his tutelary duties on superannuation in 1924. Professor Gee was the author of several books on scientific subjects and had recently contributed articles to THE ENGINEER, the latest being on the subject of Aluminium.

THE Dinajpur-Ruhea extension of the Eastern Bengal Railway was opened on the 15th ultimo. It is 47¼ miles long and of metre gauge.

High-speed Navvies and Drag Line Excavators.

WE recently had an opportunity of inspecting in operation, at the works of the makers, Ransomes and Rapier, Ltd., of Ipswich, two new examples of the adaptation of American designs of excavating machinery to English requirements. They were an electric navvy and a drag-line excavator, destined for India, made under licence from the Marion Company of America. On the same occasion we witnessed a demonstration with a steam navvy of the same general design, which is illustrated in Figs. 1 and 3 to 7 —whilst a drawing of the electrically-driven navvy is given as Fig. 2.

It may be explained at first that all these machines are mounted on caterpillar tracks, are what might be described as of the "light" type—that is to say, they have a bucket capacity of about 1 cubic yard—and are all built up on the same style of underframe. Hence the following description may be taken to hold good, to a large extent, for all three.

The basis of the whole machine is a steel casting, which can be easily identified in Fig. 5. This frame carries the two axle supports for the crawler tracks and the pivot and turning gear for the superstructure. The frames for the tracks are also steel castings. The bearing rollers are spaced closely together, as will be gathered from an inspection of Fig. 2, so as to provide an even bearing on the ground. Incidentally it is a claim of the makers that any one of these rollers is capable of sustaining the whole weight of the machine, so, as a test, we suggested that the navvy should be run over a piece of timber about 9in. by 9in., laid on a hard road. The machine surmounted this obstacle without any apparent effort or distress, and, while standing in the more or less awkward position of being partially on the obstruction and partly off, all its functions could be easily operated.

The crawler belts are made of a series of alloy steel castings of the form shown in Fig. 6, connected together by pins of specially heat-treated alloy steel. This metal has the characteristic that in service its surface becomes burnished and the pins work quite satisfactorily without lubrication. The crawler units have a slight camber, so that they will not damage a road surface, and are so formed that, when working in soft ground, mud does not tend to cling to them. The tension in the belts is adjusted by means of square-threaded screws and crossheads like those of a steam engine. The screws are always in tension. The drive for the two tracks is taken from a transverse shaft in the front of the frame. At each end of this shaft there is a dog clutch for driving a pair of gear wheels on the crawler axles. The clutches are operated by tappets on a horizontal bar fixed underneath the rotating table of the machine. When it is desired to use the clutches this bar is turned to the proper position, and the whole upper part of the machine is slewed slightly, so as to knock either of the clutches in or out. The machine can be steered accurately, and can be turned round within approximately its own length.

The whole of the superstructure is carried by the frame —illustrated by Fig. 7. It comprises a central steel casting extended by structural steel work. These extensions only carry the lighter part of the equipment, and the main stresses are rigidly confined to the steel casting. It is noteworthy that the connections for this purpose savour of American bridge design, as they are all of the pin type, and the members are either in direct tension or compression On reference to Fig. 7 it will be seen that the weight of the rotary frame is carried by four conical rollers, which bear on the 5ft. 3in. diameter ring seen in Fig. 5. The outward thrust of these rollers is taken by brass washers, and all the bearings are lubricated by grease supplied through the pipes shown. The centre pivot is a heat-treated alloy steel casting rigidly keyed into the base casting and passing through a bronze-bushed hole in the revolving frame. There is a large nut below the base frame to take up wear between the two parts, and the post is bored to accommodate the shaft which drives the travelling gear.

We may now turn to the steam-operated navvy and then revert to the electrically-driven machines, as practically the only difference is in the substitution of electric motors for steam engines, while the engines are distinctly novel for this class of work.

On the steam navvy there are three engines—one for hoisting, travelling and luffing the jib, another for racking the dipper out on its arm, and a third for slewing. They are all remarkable, for this class of work, in that they are of the totally enclosed, high-speed type, instead of the usual open type which is so liable to damage through the exposure of the working parts. Figs. 3 and 4 represent, respectively, the main hoisting engine and the racking engine, or crowding engine, as the Americans term it.

The main engine, it will be seen, is of the vertical type, which has the merit that the cylinders do not tend to wear oval through the rubbing of the pistons, and is of 6in. bore by 6in. stroke. It has piston valves, with inside admission, so that the stuffing boxes are subject only to the exhaust pressure. The valve gear is of the Marshall type. The crank case and crosshead guides are totally

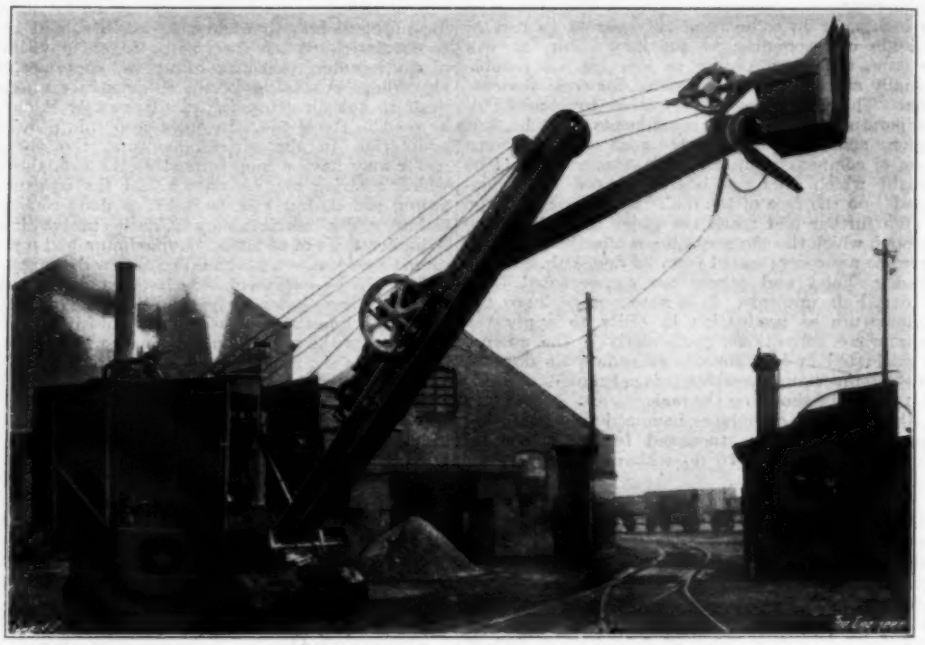


FIG. 1—ONE CUBIC YARD STEAM NAVVY

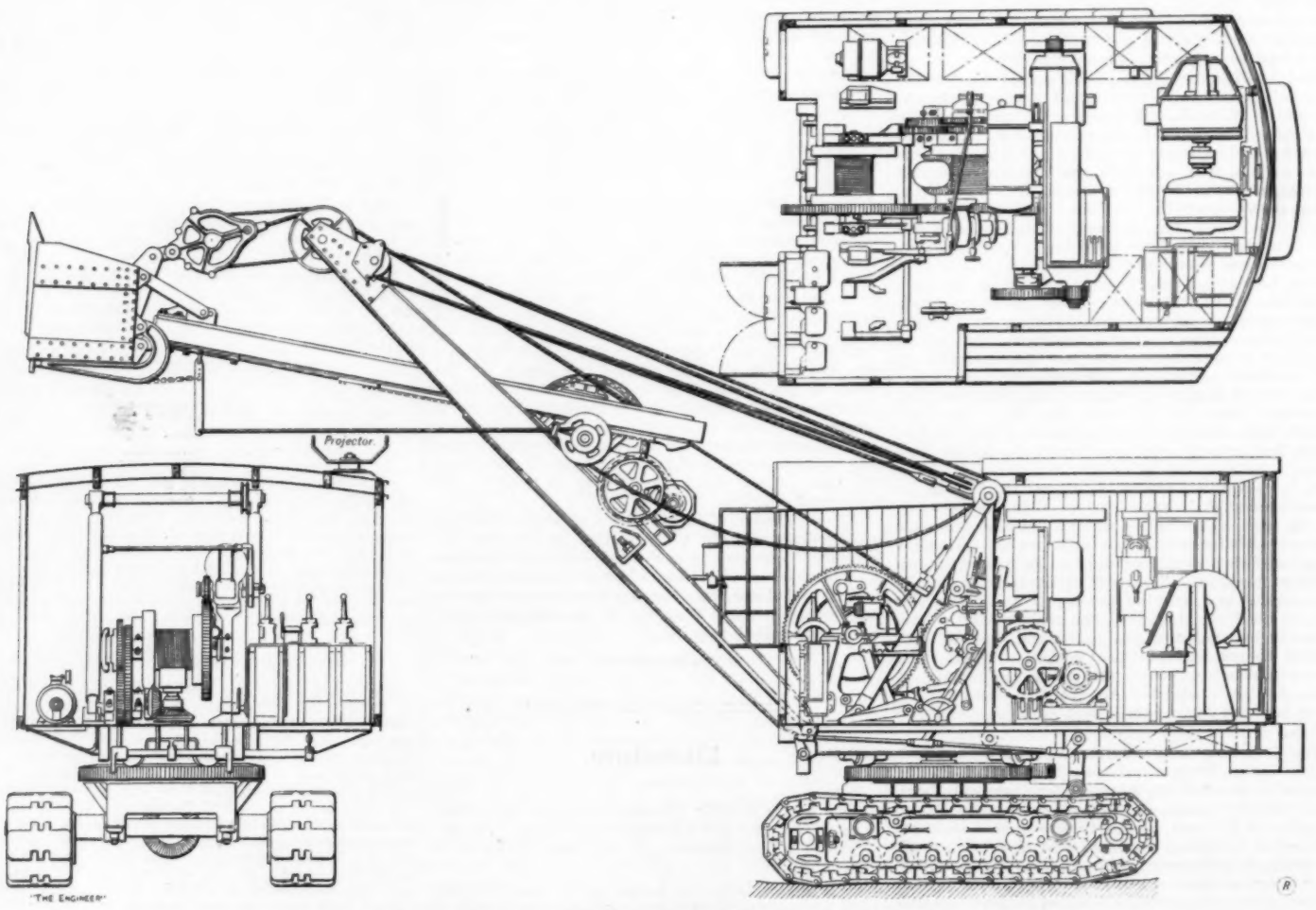


FIG. 2—GENERAL ARRANGEMENT OF ELECTRICALLY-DRIVEN NAVVY

enclosed to form an oil bath, and there is an extra stuffing-box, for the piston rod, at the top of the case to prevent the ingress of any water which may pass the cylinder stuffing-box. The throttle valve is of the balanced piston type and is very easy to manipulate. Sight feed forced lubrication is provided for those running parts not lubricated by the splashing of the cranks in their cases. The engine drives the winch through a set of machine-cut steel gears and a friction clutch operated by a steam ram. There

When the machine is to be operated as a clam shell or dragline excavator, the same main machinery is used as for a shovel, except that a forward drum shaft is provided and the ram cylinders on the front and rear drums are controlled separately. On the clam shell machine the front drum is used for the closing and hoisting cable, and the rear drum for the holding and lowering cable.

On the drag line machine the front drum is used for the drag cable and the rear drum for the hoisting cable.

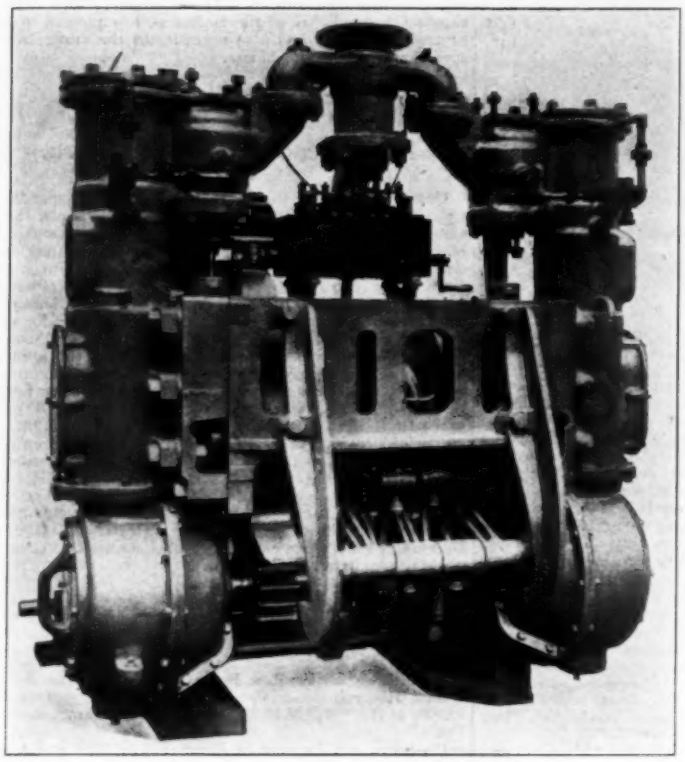


FIG. 3—HIGH-SPEED NAVVY HOISTING ENGINE

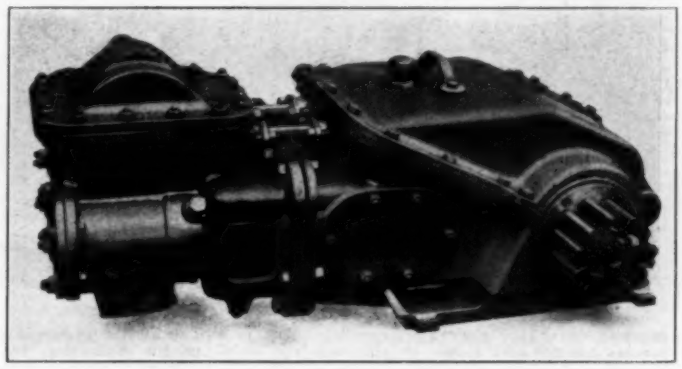


FIG. 4—RACKING ENGINE

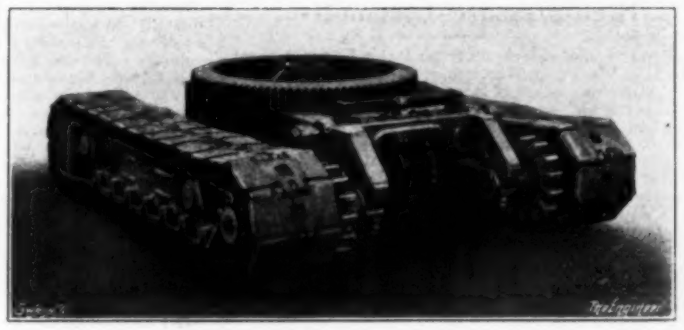


FIG. 5—BASE-PLATE AND CRAWLER TRACKS

is, of course, a brake on the rope drum; it is controlled by a foot lever. The dipper is hoisted by a three-fold purchase of ⅞in. diameter wire rope, while the jib is luffed by a fourfold purchase and a worm-driven drum worked by the main engine.

The dipper stick is racked out or "crowded" by a two-cylinder engine—see Fig. 4—fixed on the jib. This engine also is of the totally enclosed type, but is horizontal and has slide valves. The cylinders are 4½in. by 5in. The crank shaft carries a machine cut pinion engaging with a spur wheel on a shaft mounted on the jib, which, in turn, has a manganese steel pinion for working the rack on the dipper stick. Both the dipper stick and the jib are flitched, that is to say, they are of wood reinforced by steel plates.

Slewing is effected by means of an engine, similar to that on the jib used for racking, arranged on the floor and driving the turning gear by means of bevel gearing.

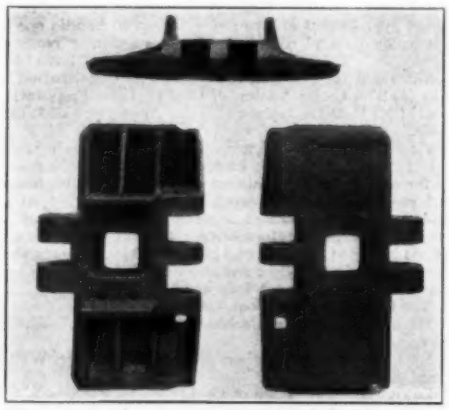


FIG. 6—CRAWLER UNITS

The travelling gear is connected with the main winch shaft by means of a jaw clutch, and includes a fourfold speed reduction gear with manganese steel pinions.

In the case of the electrically-operated sets the general construction is the same as that just described, but motors are employed in the place of the steam engines. They are of the direct-current type, and work at 250 volts. The supply is generally alternating current, so a motor generator is installed in the rear of the cab, where the boiler would otherwise be arranged. It is of 25 kilowatts capacity, and the standard motor is of 40 horse-power, three-phase, 50-cycle, 400-440 volts, but, of course, any other style of motor can be used, if necessary, to suit the electricity supply. In the place of the levers used to control the steam machine, there are three drum-type reversing controllers to operate the various movements. There is also a little motor driven air compressor, with a receiver which supplies compressed air to operate the winch clutch ram and the racking lock-brake.

The front drum shaft is geared to the motor through the rear drum shaft gear, and is supported in bearings bolted to main revolving frame casting. The front drum carries housings for both the friction clutch and check bands, in the same manner as the rear drum. The check band on the forward drum is controlled by a separate foot lever at the operator's station.

As a navvy the standard equipment of these machines is a 20ft. jib, a 15ft. dipper arm, and a 1 cubic yard dipper. With this arrangement they will dump to a height of

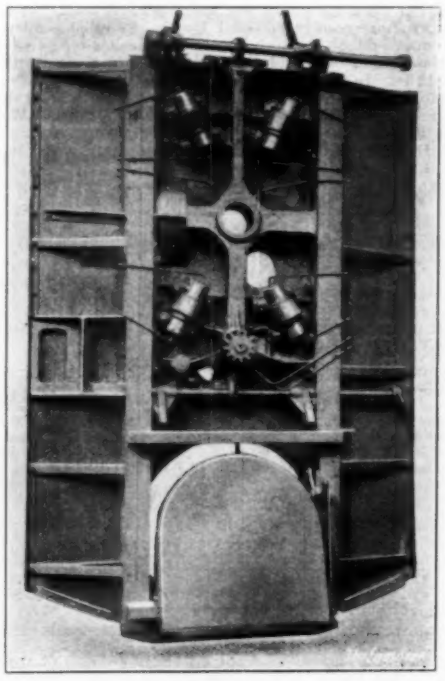


FIG. 7—REVOLVING FRAME

14ft. 8in. above grade level, and out to a radius of 26ft. 2in. They will also cut to a depth of 6ft. 6in. below grade. The approximate bearing pressure on the crawler tracks is 11½ lb. per square inch. With a 22ft. boom and a 17ft. dipper arm equipped with a ¾ cubic yard dipper the height and radius are increased to 16ft. and 29ft. respectively. The jib fitted when the machine is used as a grab crane or a dragline is 40ft. long, and the grab or skip is of ¾ cubic yard capacity. The height of dump, as a grab, is 16ft. 4in., and as a dragline 12ft. 5in.

A New Type of Rudder.

WE have received particulars of a new type of rudder from the Balanced Reaction Rudder Company, Ltd., 11, Park-terrace, Sunderland. This rudder is the invention of Mr. John Tutin, M.Sc., A.M.I.N.A., Lecturer in Naval Architecture at Sunderland Technical College. Several ships have already been fitted with the new rudder, and others are now being provided with it, including, we are informed, vessels now under construction by Swan, Hunter and Wigham-Richardson, Ltd., and the Furness Shipbuilding Company, Ltd.

In the case of a ship fitted with a single right-handed screw, the propeller blades move continuously from port to starboard above the axis of the screw and from starboard to port below the axis. The new rudder is designed to take advantage of the difference in the direction of flow imparted by the propeller to the water above and below the screw axis. As in other forms of balanced rudder, the new design pivots about an axis set some distance aft of the leading edge of the rudder. By this means the pressure of the water against the portion of the rudder in front of the pivoted axis assists the turning movement. It is stated that in the Tutin rudder the degree of balancing attained is such that the power required to move the rudder is little more than that which has to be expended in overcoming the friction at the bearings.

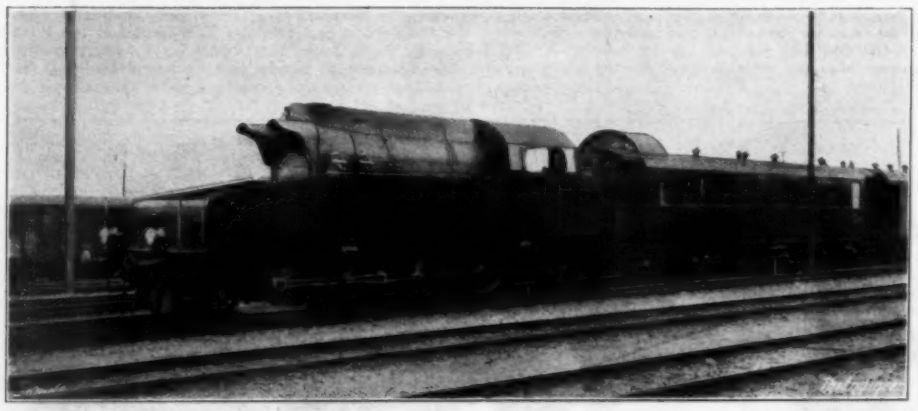
The essential feature of the rudder is not, however, the fact that it is balanced but consists in the manner in which the rudder plate is made in sections which are set angularly to one another. There are three such sections. From the top of the rudder down to the top of the propeller disc the rudder plate, when the rudder is central, is, as in the normal type, coincident with the longitudinal central plane of the vessel. From the top of the propeller disc down to the level of the propeller axis the rudder plate, if the screw is right-handed, is set with its leading edge over towards port. The third portion extending from the propeller axis to the foot of the rudder is set with its leading edge over towards starboard. The trailing edge of both the inclined portions lies on the longitudinal central plane of the ship. The rudder plates of the two lower sections are slightly concave as seen from the port and starboard sides respectively. The convex sides of the plates have their convexity considerably increased by the attachment to them of shaped timber sheathing. In cross-section each of the two lower portions follows the cross-sectional form of an aeroplane wing, the metal rudder plate corresponding to the underside of the wing, and the timber backing reproducing the upper surface. It will be gathered that looking down over the stern on both portions one would see the "upper surfaces" pointing towards each other and "lower surfaces" lying on the outside.

It is claimed that the rotational energy of the propeller slip stream, which otherwise would be wasted, generates on each of the inclined portions of the rudder a thrust which has a definite forward component. The two components, it is further claimed, increase the propulsion thrust on the vessel without any increase in the expenditure of power. Simultaneously the resistance of the rudder to movement through the water behind the vessel is, it is argued, reduced.

A development of the system consists of, in effect, forming fixed guide blades for the water in advance of the propeller. To this end the shell plating of the hull above the propeller axis is extended on the port side beyond the propeller post and curved teak filling is attached behind the extended portion. Below the propeller axis the shell plating is extended beyond the propeller post on the starboard side and similar curved teak filling is applied behind it. These extensions, it is claimed, curved as they are

850 LB. PRESSURE STEAM LOCOMOTIVE

THE SWISS LOCOMOTIVE AND MACHINE WORKS, WINTERTHUR, ENGINEERS



in opposite directions, guide the propeller inflow in a favourable manner and reduce or eliminate the eddy-making effect of an abrupt ending to the propeller post.

High-pressure Locomotive.

TOWARD the end of 1927 the Swiss Locomotive and Machine Works, of Winterthur, in Switzerland, built a trial high-pressure steam locomotive, after several years of research work, preparatory trials and stationary tests. The boiler of this novel locomotive works at a pressure of 850 lb. per square inch, and a high-speed three-cylinder non-compound engine operates the drivers through a geared jack shaft. In the middle of January, 1928, comparative road tests on the sections Winterthur-Romanshorn and Winterthur-Stein/Säckingen were made with a conventional superheated steam locomotive of 170 lb. per square inch pressure, and of equal output in order to ascertain the savings of coal and water obtainable with the high-pressure locomotive. Non-stop runs took place on consecutive days between Winterthur-Romanshorn and Winterthur-Stein/Säckingen, the composition of the train and the weather being the same for each two comparative runs. The tests were effected under the control of the authorities of the Swiss Federal Railways. The recorded test figures are given below :—

Sections	Winterthur–Romanshorn and back.		Winterthur–Stein/Säckingen and back.	
Length in miles	70		93	
Maximum gradient	1 in 83½		1 in 125	
Weight of train behind draw-bar, tons	242		300	
Number of axles	31		40	
	High-pressure	Low-pressure	High-pressure	Low-pressure
Average speed, m.p.h.	38·4	37·7	34·2	33·2
Coal consumption, lb.	1710	2600	2230	3200
Water consumption, Imp. gals.	1150	2140	1440	2690

It is claimed that there is a saving of coal of from 35 to 40 per cent. with respect to the H.P.-hour at the draw-bar, and a water economy of from 47 to 55 per cent. These remarkable figures will undoubtedly attract the attention of railway experts.

Oil Engine Performance on Coal Oils.

IN a paper contributed to a recent number of the *Journal* of the Royal Technical College, Glasgow, Mr. J. S. Brown describes some tests which he has carried out on a 35 B.H.P. Mirrlees-Diesel oil engine, with fuel oils derived from certain low-temperature processes of coal carbonisation. The engine had a single cylinder, 12in. bore by 18½in. stroke, and operated—on the four-stroke cycle—at 200 r.p.m. The tests were made in the mechanical engineering laboratories of the College under the supervision of Professor A. L. Mellanby, D.Sc.

In what follows a brief summary of these tests is given, as we believe that so far little has been done to investigate the engine performance which is to be obtained from such oils and their working behaviour in comparison with standard petroleum fuels.

The oils tested by Mr. Brown were three in number, which in the tables we reproduce are compared with an ordinary Scotch shale oil and a Bedlay coke oven oil, tested in the same engine. Particulars of these earlier tests are to be found in the paper read by Professors Gray and Mellanby before the Institution of Engineers and Shipbuilders in Scotland in January, 1914.

The first of the low-temperature carbonisation oils to be tested was the oil from the Glasgow Corporation Maclaurin plant, which may be shortly described as a form of gas producer, the coal entering at the top and being heated by the partial combustion of the charge which has reached a lower level; the "L. & N." oil came from the Barnsley plant in which the coal traverses an inclined kiln which is in slow rotation and is heated by an upward flow of inert gas entering from an external heater. The tested sample of "L. & N." oil was a distilled product described as a middle fraction. The Turner oil was the crude product from the plant at Lesmahagow, in which the heating is supplied by the direct entry of superheated steam into the retort. A further feature of this process is that the steam pressure within the retort is caused to pulsate. The Turner process is claimed to be distinctive in giving no gas production, the quantity of oil obtained being correspondingly increased.

In the report a full account of the physical properties of all the oils is given, together with their distillation curves. The specific gravities and calorific values of the three low-temperature crabonisation oils may perhaps be quoted. In the order above named, the specific gravities at 60 deg. Fah. were 1·040, 1·004, and 0·945, while the calorific values in B.Th.U.'s per lb. were 16,020, 17,046 and 17,406. Sludging tests were made by mixing a quantity of each of the oils with an equal amount of Shell-Mex Diesel oil, and in two cases there was only a slight deposit of a gummy nature. The fluidity of the oil was not decreased.

In the accompanying table of full load and low load tests, the arrangement followed has been to show the normal engine performance when running on shale oil, followed by the performance on Bedlay coke oven oil in the second column, which demonstrates the deficiencies in the latter oil. In the subsequent columns the newer low-temperature carbonisation oils are dealt with, and a comparison with the earlier columns establishes their relative positions.

At full power, two of the new oils, the "Turner" and "L. & N." oils gave satisfactory and complete records, but in the case of the "Maclaurin" oil the extreme viscosity caused the fuel pump to lose its suction a short time after changing over from the petroleum oil on which the engine had been first run up. Possibly, the author states, the oil could have quite well been handled in a heated condition, but such a modification was regarded to be outside the scope of the immediate tests. Attention may be called to variations in fuel consumption which practically disappear when the calorific values of the different oils are adjusted to a common basis of 18,500 B.Th.U. per lb.

The results obtained at the lowest available power output appear below the full power trials. Only in the case of the "Turner" oil was it possible to avoid pre-ignition when the engine was running at no load. As this condition is readily satisfied by the petroleum oils, it becomes evident, the author says, that the low-temperature carbonisation oils tend to be deficient in their ignition qualities. In the case of the "L. & N." oil, the misfiring disappeared with quite a small load on the engine, and that oil might therefore meet all practical requirements. With the Bedlay coke oven oil, misfiring was very violent at 20 B.H.P., and the lowest useful output was about 24 B.H.P., as given in the table :—

Full Load Tests.

	Fuel oil from shale.	Coal oils. Bedlay coke oven oil	Turner oil.	L. & N. oil.	Maclaurin oil.
B.H.P.	34·9	35·5	37·8	36·6	
I.H.P.	48·7	52	—	—	
R.P.M.	202	202·2	200·0	203·3	
Exhaust temperature, deg. Fah.	684	714	670	—	Engine stopped due to fuel pump losing suction
Blast pressure, lb. per sq. inch	735	706	880	765	
Cooling water, deg. Fah.	139·6	—	132	134	
Fuel, lb. per hour	16·65	19·10	20·3	19·85	
Fuel per B.H.P. hour, lb.	0·477	0·538	0·537	0·544	
Fuel per B.H.P. hour on 18,500 B.Th.U. basis	0·502	0·487	0·505	0·501	

Low Load Tests.

B.H.P.	No load	24·1	No load	No load	
R.P.M.	206·5	202·6	—	203·1	
Exhaust temperature, deg. Fah.	226	—	—	335	
Cooling water, deg. Fah.	103·2	—	115	124	
Blast pressure, lb. per sq. inch	530	635	540	490	No records
Fuel, lb. per hour	5·52	17·82	—	9·35	
Fuel per B.H.P. hour, lb.	—	0·74	—	—	
Notes	—	Records incomplete due to misfiring	No misfiring	Occasional misfiring	

The starting tests showed that none of the oils possesses the qualities shown by a petroleum oil in enabling the engine to be got under way with cold jackets, but pre-heating of the jackets to the normal working temperature gave satisfactory starting qualities with both the "Turner" and the "L. and N." oils.

The general conclusion to be drawn from the tests we have described, is, the author states, that the oils obtained by the low-temperature carbonisation of coal provide a Diesel engine fuel which is distinctly in advance of the tar oils. But there is still a slight handicap in comparison with the petroleum oils, due to a deficiency in the ignition qualities of the new oils when used with the standard injection arrangements on a Diesel engine. This defect causes the operation of the engine at low powers to be somewhat critical, and also necessitates the adoption of special starting arrangements.

Fuel Research in America.

CONSIDERATION of the possibilities that are dependent upon a greater and more exact knowledge of fuels, their constitution, production, utilisation and the economics of their distribution and use, has caused the American Society of Mechanical Engineers to take definite steps toward the correlation and extension of fuel research. In March, 1927, the Society, through its Main Research Committee, appointed a Fuels Survey Committee for the purpose of mapping out general directions and some definite plan for research in fuels. Prior to the annual meeting of the Society in December, 1927, this Committee submitted to the Main Research Committee certain general recommendations, which were officially approved and made the basis for a definite plan. In October, 1927, a "Special Research Committee on Fuels" was appointed, and authorised to collect existing data on Fuels Research, co-ordinate present research efforts where possible and advisable, and carry on research on specific problems in this field. The Special Committee held its organisation meeting during the annual convention of the Society in December, 1927, when permanent officers were elected and working plans were decided upon.

SPECIAL RESEARCH COMMITTEE ON FUELS.

The general plan, as presented to and approved by the Main Research Committee, is as follows :—

(1) *Title.*—"Research in Fuels" to be carried on by a special research committee of the A.S.M.E., and to be known as the "A.S.M.E. Special Research Committee on Fuels."

(2) *Scope and Purpose of Research.*—(*a*) The gathering and correlation of results obtained and of studies being pursued in fuel research, with the idea of making known and available, as far as possible, the progress made and the different phases under investigation. (*b*) The direction, to such extent as may be possible and advisable, of the lines of fuel research being and to be pursued, with the adoption of plans for carrying them on. (*c*) The development and conduct of definite research projects in fuels which will involve the selection of *personnel* and facilities for research and the securing of necessary funds for the carrying on of such projects.

(3) *Value to Industry.*—Research in fuel is so broad, complicated, and important both to industry and the profession, that the scope and purpose of the recommended project, as outlined in No. 2, would be of immense value, if carried out. The Committee suggested that, acting as a neutral medium between all groups, producers, distributors and consumers, it could be the means of :—(*a*) Securing all existing fuels research data; (*b*) making it available to those interested; (*c*) focussing attention upon fuels research projects that are being studied or that need investigation; (*d*) securing the necessary aid for carrying on various research projects, as deemed advisable.

(4) *Procedure.*—The Committee suggested should be divided into several groups; each group to handle one of the specific general directions to its particular research programme. The specific general subjects that have been recommended for research are :—(*a*) The Constitution of Coal; (*b*) The Carbonisation of Coal; (*c*) the Preparation of Coal; (*d*) Coal Utilisation and the Abatement of Waste in Use.

As preliminary to organising actual research work, the Committee, at its first meeting, recognising the necessity for and value of obtaining exact and definite knowledge regarding research work now being carried on or planned, decided to assign to each member the work of securing the desired information regarding his particular field, as included in the broad general subjects for research determined upon. The tentative assignment of members to specific subjects is as follows :—

"The Constitution of Coal," A. C. Fieldner.

"High Temperature Carbonisation of Coal," W. H. Blauvelt.

"Low Temperature Carbonisation of Coal," Dr. Walter Runge.

"Complete Gasification of Coal," W. H. Fulweiler.

"Other Methods of Processing Coal," Dr. H. C. Porter.

"Combustion in Domestic Furnaces (all Fuels)," J. H. McNally, F. R. Wadleigh.

"Combustion in Central Power Stations (all Fuels)," S. B. Flagg, W. J. Wohlenberg.

"Combustion in Locomotive Furnaces (all Fuels)," W. L. Robinson.

"Combustion in Metallurgical and Industrial Furnaces (all Fuels)," Professor W. Trinks.

"Preparation of Coal," J. H. McNally, F. R. Wadleigh.

"Petroleum Products as Fuel; Processes and Use; their Economic Relationships to Other Fuels," Professor R. T. Haslam, Vincent G. Shinkle.

After the available data have been secured, as outlined, the Committee purposes to decide upon the actual research activities to be inaugurated, with plans for carrying them on and for securing the necessary *personnel*, funds and facilities.

At this time, it is desired to bring the whole matter to the attention of all interested in fuels research—producers, users and the technical schools, as well as those concerned with research generally. The subjects chosen and their ramifications embrace scientific, "pure" research, as well

as utilisation research, and are, it should be needless to say, of great importance to science and industry.

The fuels field is a very broad, complicated, and important one, and a programme such as the Committee is engaging on is, it is felt, greatly needed. While a large amount of research in fuels has been and is now being, done by engineering schools, technical organisations, governmental bureaus, and industry, there is a great deal of duplication and waste. Correlation of existing information is, therefore, of first importance in approaching the subject.

The Railway Year.

By the continued courtesy of the secretaries of the various railway companies, we are enabled to give, in the accompanying Table I., the results of their railway working last year. These results, we would have it noted, are of railway working only, and take no account of the ancillary businesses of docks, steamers, hotels and canals. We are not concerned, either, in the disposal of the amount of net revenue. As the usual corresponding year—that of 1926—was abnormal, we have included the results for 1925 as well as those for 1926.

Table II. is also abstracted from the annual reports. The first two entries are useful as showing that a less proportion of the companies' receipts now comes than formerly from passenger traffic. The next items, as indicating the relation of expenditure in the six main branches to the receipts, are useful because they reveal that, should the traffic be falling off, the percentage borne by expenses is not allowed to go up. Those particular results are summed up in the last entry of Table II.

Table III. has been compiled by ourselves, and is intended, first, to show the results of 1927 as compared with 1925, and, secondly, to afford us an opportunity of drawing attention to any particular feature worthy of notice.

TABLE I.—*Receipts and Expenditure on Railway Working, 1925, 1926, and 1927.*

	London, Midland and Scottish.			London and North-Eastern.			Great Western.			Southern.*		
	1925.	1926.	1927.	1925.	1926.	1927.	1925.	1926.	1927.	1925.	1926.	1927.
Passenger traffic receipts, £	32,519,020	28,558,639	30,164,597	21,565,773	19,149,792	20,019,411	13,833,900	12,529,901	13,149,871	17,541,271	16,494,055	17,066,989
Goods traffic receipts, £	44,066,095	36,626,758	45,980,659	33,530,158	26,650,583	36,158,586	16,852,730	13,759,970	18,066,983	6,198,952	5,445,331	6,177,724
Receipts from railway working, including miscellaneous, £	78,911,113	67,273,898	78,497,572	58,217,639	48,571,313	59,369,357	31,337,444	26,914,576	31,853,884	24,170,294	22,324,555	23,670,592
Expenditure on railway working, £ ..	64,869,156	61,047,507	62,791,644	50,147,215	45,646,105	48,894,655	25,890,173	23,636,068	25,399,007	19,665,616	19,135,929	19,286,260
Net receipts from railway working, £ ..	14,121,957	6,226,391	15,705,928	8,070,424	2,925,208	10,474,702	5,447,268	3,278,508	6,454,877	4,504,678	3,188,626	4,384,322

TABLE II.—*Proportions of Passenger and Goods Receipts and of Expenditure to Traffic Receipts.*

	L.M.S.			L.N.E.			G.W.			Southern.		
	1925.	1926.	1927.	1925.	1926.	1927.	1925.	1926.	1927.	1925.	1926.	1927.
Proportion of traffic receipts : From passenger traffic, p.c.	42·46	43·81	39·61	39·14	41·81	35·64	45·08	47·59	42·12	73·89	75·18	73·42
From goods traffic, p.c. ..	57·54	56·19	60·39	60·86	58·19	64·36	54·92	52·41	57·88	26·11	24·82	26·58
Proportion of railway working expenditure on : Way and works, p.c. of traffic receipts	11·05	11·42	10·46	11·90	11·92	10·72	14·32	13·82	13·12	14·05	13·69	14·24
Locomotives, p.c. of traffic receipts	6·69	6·82	6·79	7·89	7·60	7·33	6·56	7·27	6·77	6·32	6·38	6·26
Carriages, p.c. of traffic receipts	3·73	3·94	3·79	3·75	3·45	3·69	3·56	3·79	3·55	4·55	5·25	4·70
Wagons, p.c. of traffic receipts	3·68	3·64	3·50	5·22	4·80	5·49	3·23	3·19	2·99	1·78	1·92	1·72
Locomotive running, p.c. of traffic receipts	20·71	25·07	20·11	21·13	26·25	20·73	20·40	22·39	19·27	20·50	22·66	20·53
Traffic, p.c. of traffic receipts	28·56	30·98	28·08	29·60	32·34	28·10	27·23	28·80	26·20	24·58	25·36	24·39
Proportion of railway working expenditure to traffic receipts, p.c.	82·62	91·46	80·57	86·99	95·16	83·18	83·62	88·99	80·50	81·65	86·09	81·99

TABLE III.—*Comparison of Results of* 1927 *with those of* 1925.

	L.M.S.	L.N.E.	G.W.	S.
Passenger receipts ..	−7·24	− 7·17	−5·29	− 2·70
Goods receipts	+4·35	+ 7·85	+7·21	− 0·34
Total traffic receipts ..	−0·57	+ 1·97	+1·77	− 2·09
Maintenance and renewal—				
Way and works ..	−5·86	− 8·09	−6·84	− 0·69
Rolling stock	−0·72	− 0·14	+1·31	+ 0·34
Locomotive running, including fuel ..	−3·42	+ 0·04	−3·93	− 1·92
Locomotive fuel alone	−9·39	− 1·29	−8·57	− 9·99*
Traffic expenses	−2·28	− 3·21	−2·11	− 2·85
Total expenditure ..	−3·20	− 2·50	−1·99	− 1·93
Loaded passenger miles				
Steam	+0·22	+ 0·12	+2·00	− 7·56
Electric	+3·30	− 0·74	−1·60	+74·00
Number of passengers	−9·45	−13·41	−6·06	− 0·90
Loaded goods miles	+1·78	+ 2·75	+1·53	− 0·75
Tonnage	+1·48	+ 3·77	+3·02	− 0·23

* The decrease of £207,322 was offset by an increase of £236,171 in electric traction current.

All the companies experienced decreases last year, when compared with 1925 in their passenger receipts. We offer four suggestions as to the cause for that :—(1) The year 1925 enjoyed the continuation of the British Empire Exhibition ; (2) the coal stoppage in 1926, with its effect, too, on other trades, reduced the spending capacity of many in 1927 ; (3) the abnormally bad weather in the summer of 1927 ; and (4) road motor transport competition was more severe. The lesser decrease experienced by the Southern Railway, in spite of less money being available for pleasure, the adverse holiday weather, and road transport competition, was, no doubt, due to the 74 per cent. increase in the mileage of its electrical train services.

The increase in the goods receipts was greater than the increase in the tonnage—see the last entry—so a good deal of it may be set down to the advance in some rates made in February, 1927. The greater receipts on the London, Midland and Scottish were less in proportion than those of its neighbours, and did not, as with the latter companies, wipe out the loss on the passenger business. Its total expenditure—see the ninth entry—was, however, less.

It is in the maintenance and renewal of way and works that the companies, except the Southern, have probably effected the greatest of their economies. The reason why the Southern has not been able to do as well, no doubt lies in the large amount of replacement—a revenue charge—caused by electrification.

The small reduction, compared with the London, Midland and Scottish decrease, in the maintenance and renewal of locomotives and rolling stock on the London and North-Eastern, was due to the fact that in 1925 the sum of £1,380,575 was taken from suspense account to meet £500,000 and more for the complete renewal of wagons ; £400,000 and more for repairs to wagons ; and £400,000 for the purchase of new wagons. In 1927 there was, moreover, a payment—of £165,908—to the suspense account. The results would have been better but for the company taking advantage of the opportunity to purchase for £163,040, some locomotives from the Disposals Board. The Great Western increase was due to £688,971 being taken in 1925 from the renewal funds for locomotives and, in contrast, in 1927 there was a payment of £38,866 to the funds. On the Southern the total withdrawn in 1925 from suspense accounts for locomotives, carriages and wagons was £1,043,333 ; in 1927, on the contrary, the locomotives accounts paid in £90,103 to the locomotive renewal fund and £93,290 to the carriage renewal fund, but £115,374 was withdrawn for wagons.

It is difficult to account for the London and North-Eastern being singular in an increase in locomotive running expenses, except that wages to enginemen increased by £100,000. That company's fuel bill was reduced by a lesser proportional amount than those of the other companies. Mr. Whitelaw, the chairman, at the annual meeting on March 2nd, was apparently satisfied, having regard to the increased mileage run. We would, however, point out that whilst the L. and N.E. total engine mileage did increase by 1·54 per cent. over 1925, the Great Western increased by 1·85 per cent., and yet 8·57 per cent. was saved in fuel. Our conclusion is that the former company has been at a disadvantage over its foreign coal contracts made during the coal stoppage. That assumption finds strength in the fact that a year ago Mr. Whitelaw was complaining that the foreign coal contracts had to run for some considerable period in 1927, as short contracts could not be obtained for the quantities required. The reduction of 3·21 per cent. in the L. and N.E. traffic expenses—which means the operating and commercial side of a railway—is very satisfactory.

The reduction in the total expenditure effected by each company is worthy of the highest praise. The two smaller companies have not done as well as the two northern companies, but they have not the same area wherein to effect possible retrenchments. On only one other matter does comment appear to be necessary. It is in the increase in the passenger train mileage, despite the fewer number of passengers, and the reduction in passenger receipts. The explanation for that anomaly is to be found in the very unsatisfactory but quite necessary fact that the train services have to be maintained, even although they are less well supported.

THE power station at Moose Jaw, Saskatchewan, has been equipped with a 5000-kilowatt steam turbine.

Turbo-Electrically-Propelled Passenger Liners.

IN our issues of September 9th and October 21st last we gave some particulars and illustrations of the 22,000-ton turbo-electrically-propelled passenger liner "California," which, last month, completed her successful maiden voyage from New York to San Francisco. As we have already described the hull and propelling machinery, we shall confine ourselves in the present article to a summary of the particulars, with a brief account of the trial results and the performance of the ship on the first voyage, after which some comparisons with the new P. and O. liner "Taj Mahal" will be made. Several British engineers took part in the trials and the maiden voyage, among whom we may mention Mr. W. J. Belsey, of the British Thomson-Houston Company, Ltd.; Mr. Willett Bruce, representing the White Star Line ; Mr. R. T. Clarke, the superintending engineer of the Peninsular and Oriental Steam Navigation Company ; and Mr. A. S. MacLellan, of Alexander Stephen and Sons, of Linthouse, Glasgow. The reports of these engineers all pay tribute, we understand, to the very successful operation of the ship and her freedom from vibration.

The "California" has a length of 601ft., with a beam of 80ft., a gross tonnage of 22,000, and a designed speed of 18 knots. She was built by the Newport News Shipbuilding and Dry Dock Company, of Virginia, and was engined by the General Electric Company, of Schenectady, for the service of the Panama Pacific Line, a subsidiary company of the International Mercantile Marine Company, of New Jersey. A sister vessel is in course of construction, and the order for a further ship will shortly be placed, which will, we understand, have high-pressure boilers, and a closed ventilating system for the alternators and motors similar to that which is to be installed in the new P. and O. liner. The propelling machinery comprises a twin-screw arrangement of General Electric propelling motors, which at 18 knots have a total output of 17,000 S.H.P. The main generator units consist of two General Electric marine type steam turbines and alternators, each rated at 6750 S.H.P., when running at 2640 r.p.m., corresponding to a propeller speed of 110 r.p.m. At 2880 r.p.m. they are designed to develop 8500 S.H.P. each, corresponding to a propeller speed of 120 r.p.m. Steam is raised in twelve water-tube boilers of the Babcock-Wilcox type, which are fitted with Peabody type oil burners. These boilers are designed for a working pressure of 275 lb. and 120 deg. Fah. superheat. The three-phase alternators and the propelling motors are operated from a central control panel, which is provided with four levers by the movement of which all the reversing and manœuvring operations can be carried out. The auxiliary units comprise four 500 kW turbo-generator sets.

The official trials of the "California" took place off Newport News on January 7th last, when the vessel was subjected to very exhaustive tests. The measured mile trials were run with a mean displacement of 21,700 tons and a mean draught of 24ft. There was only a depth of about 56ft. of water over the trial course. With one generator driving both motors, a mean speed of about 15 knots was obtained, and when both generators were in use the speed of the ship was over 18 knots, the mean shaft horse-power for these two trials being 8750 and 17,300. After the trials the vessel left New York on January 28th for San Francisco, *viâ* the Panama Canal. During the trip from New York to Panama, heavy weather was encountered, but the ship behaved splendidly, and the passengers commented, we learn, on the freedom from vibration at full speed and the generally comfortable conditions which were maintained. Between Panama and San Diego a very good passage was made and the distance of 2839 sea miles was covered with a fuel expenditure of about 103 tons of oil fuel per day for all purposes, including the propelling, auxiliary and "hotel" load. The make-up lubricating oil for the turbine machinery only amounted, we understand, to 2 gallons per day. During this part of the trip the "California" had a mean displacement of 26,000 tons and she maintained an average speed of 16¼ knots. During both the trials and the first voyage, no attempt was made to obtain maximum efficiency.

These satisfactory results should be particularly gratifying to the Peninsular and Oriental Steam Navigation Company, whose new liner the "Taj Mahal," of almost identical size, is being built by Alexander Stephens and Co., Ltd., of Linthouse, Glasgow, and will be engined by the British Thomson-Houston Company, Ltd., of Rugby. In the British ship, however, even better results should be obtained, for with the 100 lb. increase in boiler pressure and with an increased degree of superheat of 164 deg. Fah. it has been found possible to guarantee a fuel consumption for propulsion purposes only of less than 0·6 lb. per shaft horse-power per hour at a speed of 18 knots.

The propelling machinery of the "Taj Mahal" comprises two B.T.H. steam turbine driven alternators, which, when running at 2690 r.p.m., are each capable of delivering 11,600 S.H.P. at the propellers, which, with an average voyage displacement, corresponds to a speed of 16¼ knots. The two propelling motors are designed for an output of 8500 S.H.P. each at 109 r.p.m., and when both alternators are running at 3052 r.p.m., the power developed by the

motors will be 17,000 S.H.P., which is equivalent to a speed of 18¾ knots on the same displacement.

As each of the turbo-alternators referred to is capable of driving the ship at a speed of 16½ knots, there is always a complete stand-by unit. The boilers, which are of the Yarrow superheater water-tube type, are six in number, and will be arranged in two engine-rooms, two being placed in the forward and four in the after engine-room. Only the four after boilers will be in service when the ship is steaming at 16½ knots. The boilers are designed for a working pressure of 375 lb. per square inch, with a blow-off pressure of 400 lb., and with a total steam temperature of 700 deg. Fah. They will be fed with distilled water and are to be fired on the Clyde oil fuel system, and a forced draught fan is provided for each boiler, driven by an Austin constant current motor. The boilers will have an efficiency in the region of 84 per cent. It should be remarked that the boilers are so designed that they can be readily changed over to use either fuel oil, run-of-mine coal, or pulverised fuel, should circumstances at any time require such a change to be made. As there will be a complete stand-by alternator when the ship is running at 16½ knots, the question of trouble with leaky condensers is quite overcome; also, the alternator is being run at maximum efficiency, and is expected to show a gain of at least 3 per cent., as compared with a geared turbine installation. Great care has, however, been taken in the design of the condensing system which is of the latest Weir regenerative type working on the closed feed system, with steam ejectors, motor-driven water extraction pumps, and turbo-feed pumps, along with three surface type heaters, giving a feed temperature of 300 deg. Fah. The working vacuum will be about 28in. of mercury, with an inlet water temperature of 82 deg. Fah. The auxiliary units consist of four 500-kW B.T.H. turbo-generator sets, which will be supplied with superheated steam. These sets will supply current for lighting and power and all the engine-room auxiliaries, with the exception of the turbo-feed pumps, are to be electrically operated. For harbour use, two 150-kW Petter heavy-oil engines are to be fitted. They will provide sufficient power for the lighting and services of the ship when the main auxiliaries are shut down. The same engine builders are to supply a 50-kW emergency lighting set.

A Gear-Driven Train Lighting Set.

A SYSTEM of driving the dynamos used for train lighting, which eliminates most of the objections to the orthodox belt drive, has been evolved in France, and some equipments of the kind have already been made for the Chemin de Fer de L'Est by the Société des Engrenages Citroen, of Paris. The idea is being introduced into this country by Mr. A. J. Markower, of 200, High Holborn, and is illustrated by the accompanying engraving and drawings.

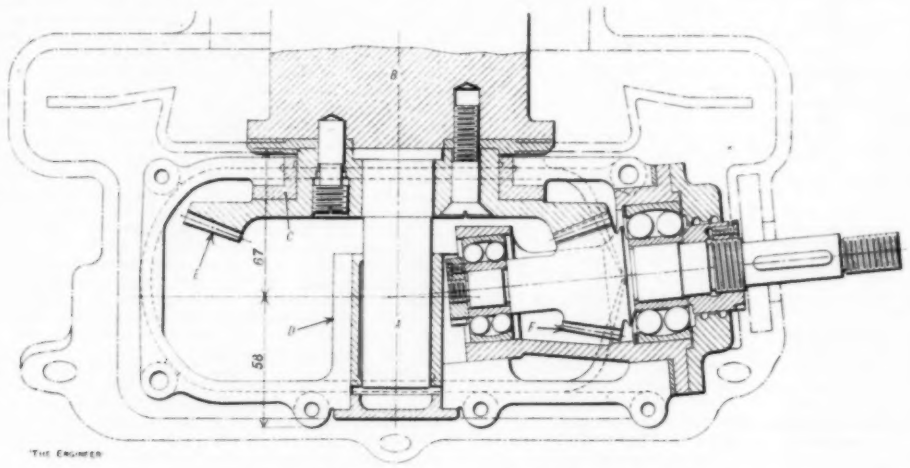


FIG. 1—SECTION THROUGH GEAR DRIVE

The chief objection to the normal belt drive for a train lighting dynamo is, of course, the fact that the belt may break at a time when it cannot be attended to, and then the battery has to take up the whole of the lighting load. We understand that such troubles occur in France, and that the batteries, as a consequence, are sometimes run down much below their proper limit.

The alternative arrangement of driving the dynamo by means of toothed gears suffers from the handicap that the axles of the coaches are constantly moving, in relation to the framework, while there is also the wear of the bearing to take into account as regards the alignment of any exterior mechanism. The gear drive has, nevertheless, the merit that a greater speed ratio can be adopted and the size of the dynamo may be correspondingly reduced.

The essence of the idea of the gear under review is to attach the transmission wheels to the end of the axle itself, so that they share in its movements, and then to transmit

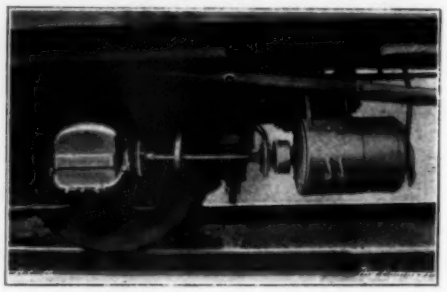


FIG. 3—GEAR-DRIVEN TRAIN LIGHTING DYNAMO

the power to the dynamo through a shaft fitted with flexible couplings.

On reference to Fig. 1 it will be seen that a short stub shaft A is pinned on to the end of the axle B. On this shaft there is hung a casing, to contain the gearing, by means of the bearings C and D. This casing is free from the main axle-box, but is prevented from rotating with the axle by means of a loose-fitting peg. On to the stub axle A there is keyed a bevel wheel E that meshes with a corresponding pinion F, mounted on a short shaft carried by ball bearings in the free casing.

It will be readily appreciated that with an arrangement such as this the gear wheels must be kept in proper meshing engagement regardless of the movements of the main axle, and that it is only necessary to provide adequate flexibility in the shaft connecting the gear with the dynamo to have a satisfactory drive. There is, however, one other matter which requires attention, and that is the inertia of the dynamo armature. It is quite conceivable that if the train were stopped very suddenly the inertia of the armature would put a severe stress on the driving gear. So a slipping clutch G—see Fig. 2—is introduced to take up any such shocks. This illustration also shows very plainly the form of the flexible couplings used on the driving shaft, which are of familiar design. It is noteworthy, on reference to the half-tone engraving—Fig. 3—that the whole of the apparatus is unusually accessible.

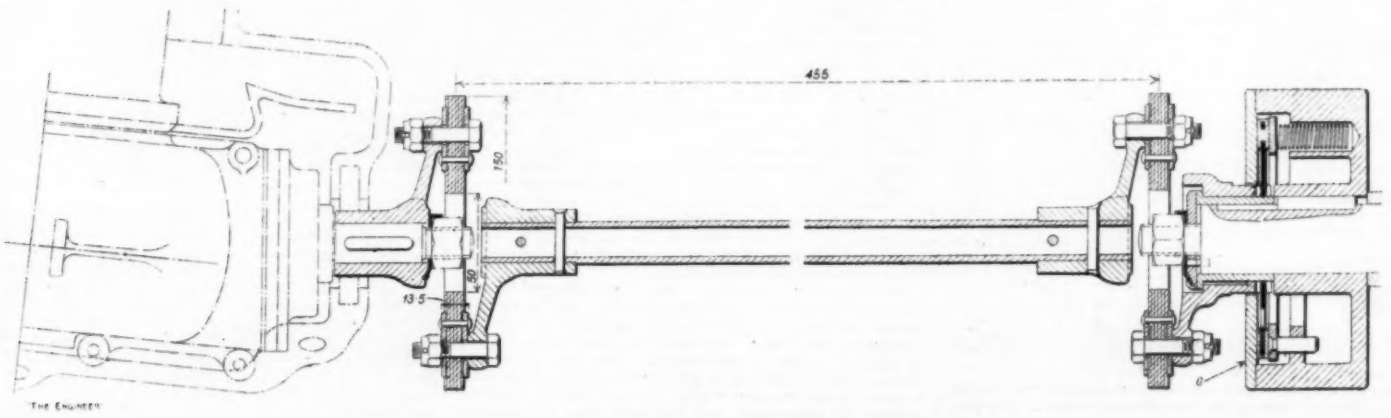


FIG. 2—ARRANGEMENT OF FLEXIBLE COUPLINGS AND SLIPPING CLUTCH

We understand that an experimental coach fitted with the appliance has completed 50,000 kilometres of running in France without developing any trouble.

THE MICHELL CRANKLESS ENGINE.

IN the special British Industries Fair Supplement accompanying our issue of February 24th there will be found an illustrated description of one of the smaller sizes of the Michell crankless gas engine, built by the National Gas Engine Company, Ltd., of Ashton-under-Lyne. Those who are interested in the probable future of this particular form of prime mover, particularly when it is built as an oil engine, may turn with advantage to the paper which was read by Mr. G. U. L. Sartoris and Mr. Kenneth Watson before the North-East Coast Institution of Engineers and Shipbuilders on Friday, February 24th. After describing the advantages of the crankless engine, and pointing out the relatively high mechanical efficiency which it is possible to obtain with it by application of the Michell wedge-film system of lubrication, particulars are given of cut-out tests made on crankless gas engines of 100 B.H.P. and 280 B.H.P. output, in which at full load mechanical efficiencies of 89·3 and 86·25 were obtained. Designs are illustrated of an eight-cylinder crankless oil engine working on the four-stroke cycle of operation, which would have an output of 600 B.H.P. at 500 r.p.m., and also an eight-cylinder two-cycle unit designed to give 6500 B.H.P. when running at a speed of 160 r.p.m. In the proposed engine last mentioned the scavenge ports would be controlled by rotary valves driven by gearing from the main shaft.

The remainder of the paper is devoted to some possible applications of the Michell engine for marine work. The type of engine chosen for this purpose is an eight-cylinder unit, which would work as a Diesel engine on the four-stroke cycle principle. The possible saving in space and weight in the case of an auxiliary engine is shown by comparing a 375 B.H.P. crankless engine during a 250 kW generator with a normal six-cylinder crank type engine of similar output. Drawings are given, and comparisons worked out for a twin-screw Michell Diesel-electric installation for 7000 S.H.P. total output. In this proposal two 3500 B.H.P. propelling motors are shown, to which current would be supplied by eight crankless oil engine driven generator sets. The engines would each have a designed output of 1000 B.H.P. at 400 r.p.m. Three 375 B.H.P. 500 r.p.m. auxiliary sets would be required for this scheme.

Particulars of a single-screw installation of the same type are also put forward, in which it would be proposed to install two 1300 B.H.P., 350 r.p.m. main generator units and three 100 kW 500 r.p.m. auxiliary sets.

A similar installation is shown with twin Michell oil engines combined with Beardmore hydro-mechanical gearing, having ahead and astern clutches. Full details have been worked out for each type of installation. The authors consider that a multi-cylinder engine, which does away with problems arising from the use of a crank shaft, will have an important part to play in the possible future development of high-speed oil engines having low power-weight ratios.

THE Canadian Finance Minister submitted estimates for the year to Parliament on February 9th. The appropriation asked for capital expenditure on railways and canals was 20,203,500 dollars, which includes 6,500,000 dollars for construction and betterments in connection with the Hudson Bay Railway and termini and the Welland Ship Canal at 13,750,000 dollars. In the Marine Department there is an appropriation of 1,000,000 dollars for the construction of regulation and retaining dams in the St. Lawrence River, with a view to raising the level of Montreal Harbour by 2ft. A vote of 1,500,000 dollars is asked for the Lower Lakes terminus and grain elevators at Prescott. Appropriations for public works include 500,000 dollars for a new Custom house in Toronto, 650,000 dollars for a Montreal terminus postal building, and 750,000 dollars for the National Research Council laboratory in Ottawa. The establishment of this laboratory has been for some time urged upon the Government, both by scientists and those interested in the industrial development of the country in order that Canada may be placed upon an equality with other countries as regards industrial research. The plan to be adopted as outlined some time since by the Government, in addition to the researches to be carried on by a permanent staff, will permit manufacturers or others interested to send their own experts to carry on investigations on their own account.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

An Improved Tone.

THERE is less apathy in the iron and steel industries of the Midlands and Staffordshire, and the rather better feeling which has been prevalent of late has resulted this week in an improved market tone. The steadiness of prices and the gradual expansion of demand in a number of branches of Midland industry lend strength to the hope that before long the activity will extend to pig iron and steel. Engineers generally report a fair volume of inquiry. Mechanical engineers maintain a steady output and substantial orders for heavy engineering equipment are reported to have been booked. Constructional engineers have fair contracts in hand and more in prospect. Motor engineers are busy and anticipate a big rush of orders now that the weather shows signs of improving. There is a good and regular demand for small tools and accessories, and in many directions there are indications of steady progress. The Midland steel works are rather busier, and are likely to secure additional business as the stiffening of continental values brings prices nearer to our own. Smelters are already on equal terms with their foreign competitors, but in this department there is an almost unaccountable slackness in consumptive demand. Material prices on the Birmingham market remain steady. Orders are mostly for short date delivery, although they are more frequent than of late, which is a matter for some congratulation.

Pig Iron.

Rather more buying of pig iron is taking place, both forge and foundry grades joining in the slight fillip. Tonnages continue small, and furnaces have no difficulty in giving early deliveries, though stocks are being gradually reduced. There does not appear to be any immediate prospect of further furnaces being put into blast in this district. Buying of continental iron has ceased. Pig iron, even at the seaboard, can now be bought on as favourable terms from blast-furnaces at home as from those abroad, transport costs being taken into account. Derbyshire No. 3 foundry is maintained at £3 4s., forge at £2 19s., Northamptonshire foundry £3, forge £2 14s., North Staffordshire foundry £3 3s. 6d. The Midland foundries are still short of orders, and the forges show only a slight improvement. Foundry quality iron is consequently selling but slowly. With the advance of spring, a larger demand for light castings is expected, and progress in engineering encourages a hope of more business from the heavy foundries. Forge pig cannot be produced at a price which makes it worth the while of consumers to buy far forward. Furnaces which produce basic pig are kept well engaged by affiliated mills. Consumers of raw iron continue to express amazement at the remarkable steadiness of quotations considering the prolonged inertia of the market.

Steel.

The order books of the majority of the Midland steel mills have much improved of late. How much of the new business is due to the securing of work which normally goes to foreign competitors it is difficult to state, but there can be no doubt that the comparatively high price of continental steel is having a beneficial effect on the steel trade locally. Native steel prices remain unchanged, the new level having been generally adopted. Plates cost £8 12s. 6d. and joists £7 17s. 6d. Boiler plates £11, and Staffordshire hoops £10 10s. at works. Most semi-finished material is very near to the prices charged by continental makers. Continental billets have been increased again by 2s. 6d., making the quotation £5 15s., exactly the same figure which is charged by a well-known South Wales firm which is selling large quantities to re-rollers in this district. Continental joists were quoted in Birmingham this week at £6 5s. Foreign steel bars at £6 10s. offer no advantage as compared with English steel, while the slow delivery of foreign material is a factor weighing heavily against its use here. From two to three months is mentioned by some foreign works. Sales of foreign steel are few and far between, although a few consignments of cheap Belgian iron come in for nut and bolt making. The changed relationship of native and foreign prices is operating, though slowly, to divert to the blast-furnaces and mills at home orders which formerly were going abroad. Some steel masters state that they are getting better inquiries for plates, and they think the tide is now turning. From the recent course of the market it would appear that the upward movement in continental prices has not yet come to an end. On 'Change in Birmingham to-day—Thursday—it was reported that constructional steel orders are coming in with more regularity, though the smallness of tonnages is disappointing. Engineers are experiencing a steady flow of inquiries, and some good contracts are expected in the near future. Prominent among overseas buyers are Indian and South American railways.

Staffordshire Iron Trade.

There is no further progress to be reported in the Staffordshire finished iron trade. Forges and their affiliated rolling mills are doing just a little better than they were a month ago, but the volume of trade has been so variable that those engaged in the industry hesitate to say that there is any real expansion of activity. The trade is mainly indebted to prospective requirements of the shipbuilders for such business as is experienced. Chain and anchor makers are not working up to capacity, but some of them have very favourable order books, and the rolling mills are feeling the impulse. Marked bars remain at £12 10s. For Crown bars the price varies from £9 7s. 6d. to £10 5s. A few orders for South Africa and other export markets have been received and are much welcomed. Common bars for the nut and bolt and fencing trades are named £9. Demand is small. Staffordshire ironmasters are looking for vastly improved business from the engineering industry as the spring advances.

Galvanised Sheets.

The upward movement in galvanised sheet prices continues, the quotation for 24 gauge corrugated now being £13 10s., both for home and export business. It is reported, however, that some mills are still willing to accept last week's figure of £13 7s. 6d. for substantial export orders. Very good business has been booked for India, South America, and South Africa. In spite of the excellent demand, a number of the mills have not yet found it possible to restart. Owing to the severe slump at the beginning of the year, several large houses dispersed their employees, and now find considerable difficulty in getting them together again.

Scrap.

Steel scrap is firm at £3 delivered South Wales. The improvement in the tin-plate and sheet trades has helped to stimulate the demand for scrap for melting requirements.

Tube Firms Busy.

Midland tube works are very busy. Good quantities of strip are sold at £11 10s. for wrought iron and £7 15s. for steel. The country merchants are calling for better supplies from the Staffordshire mills, and have placed very acceptable orders.

Rolling Stock.

The rolling stock works of the Midlands are fairly well employed, though there is not enough work to keep all the plant in operation. Birmingham works are securing new business from time to time, but while this maintains employment at a fair level, the shops are not turning out anything like the output of which they are capable. Better times are anticipated, however, and makers are looking to the considerable railway developments in progress in different parts of the Empire to provide the bulk of the new work. Home railways and private traders are giving out but few contracts, and little is expected from these quarters for some time to come.

Steam Rail Coaches.

The Sentinel Waggon Works, Ltd., of Shrewsbury and Westminster, has secured from the London and North-Eastern Railway Company a contract for a further twenty steam rail coaches, each of which will give seating accommodation for fifty-nine passengers. This is understood to be the largest individual contract ever placed by any railway company for self-propelled rail coaches. The vehicles, I learn, are intended for operation on selected sections of the railway in the southern, north-eastern and Scottish areas, to provide improved train services, more especially in districts in which there is severe competition from omnibuses and road transport. The company already has in service or on order twenty-four of these Sentinel-Cammell steam rail coaches.

Warwickshire Miners' Wages.

Warwickshire miners' wages during March are to remain on the agreed minimum of 43 per cent. above the basis rate, though the actual ability of the owners to pay is only 38·76. The Warwickshire Coalfield Wages Board ascertainment governs the wages at fourteen out of the sixteen collieries in the county. The rate of wages earned in January was 10s. 2d. per man shift, including boys. The output of coal for January per man shift was 20·37 cwt. which is higher than that for some months previously.

Unemployment.

A slight increase of 126 is recorded in the latest unemployment returns for the Midlands, the total being 139,064, against 138,938 a week ago. Of the total, 105,580 are men, 26,676 women, 3386 boys and 3422 girls. In the Birmingham area the figures have advanced from 25,954 to 26,283, and at Coventry from 3052 to 3081. Increases are also recorded at Cradley Heath and Wednesbury, but other Black Country towns show improved returns.

Malleable Castings.

In this column on February 24th I gave a brief account of an address given by Mr. H. Field on "Malleable Castings." In this report I said by mistake that Mr. Field was connected with the firm of W. Harper Sons and Co., of Willenhall. Mr. Field is, as a matter of fact, metallurgist for John Harper and Co., Ltd., Albion Works, Willenhall.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Industrial Outlook.

RATHER mixed conditions in the engineering and allied industries are indicated by the Manchester Chamber of Commerce in the course of its monthly review of general trade conditions. Discussing the outlook in engineering, it is said: A number of engineering firms have experienced an improvement in the demand for their specialities, but others have not been so fortunate. Textile machinists are getting a fair number of orders from looms, but in some cases not as many as they would like for spinning machinery. There are no signs yet of a revival in home business, and it does not appear that much has been done for India or Japan, but a moderately good trade has been done for the Continent and South America. Leading electrical engineers continue to be well employed, and some locomotive builders in Lancashire and Yorkshire are well supplied with orders. Motor car building firms have placed a good many orders for castings and gears, but constructional engineers' news is not quite so good as it has been.

Manchester Chamber of Commerce.

The officers and committee of the Engineering and Metals Section of the Manchester Chamber of Commerce for the current year have been elected as follows:—Chairman, Sir B. Longbottom; vice-chairman, Mr. L. F. Massey; and honorary secretary, Mr. Harry Allcock; Executive Committee: Messrs. H. Arundel, E. R. Brayshaw, E. V. Haigh, L. E. Mather, H. B. Noble, Hans Renold, Alfred Saxon, J. H. Stubbs, Leonard Sumner, F. J. West, W. H. Whitby, and Walter Yates.

"Buy British Steel."

Speaking at the annual meeting of Leyland Motors, Ltd., at Leyland, near Preston, Mr. J. H. Toulmin, chairman of directors, said that the whole of the material, including the steel, used in the manufacture of the company's products, was produced in this country. The directors, he said, were strong believers in the policy of supporting home industries, and considered that large manufacturing companies in this country, including motor firms, should buy their steel from British producers, and so do what they could to further the welfare of one of the country's great staple industries. As was the case with the steel, so it was with the castings employed in the machines manufactured by the company. These came either from the company's own foundries or from firms in this country.

Obituary.

Mr. Frank Robinson, well known as a consulting mining engineer in Lancashire, who resided at Parbold, near Southport, has died in Scotland at the age of sixty-nine years. Forty years ago Mr. Robinson was appointed manager of the Norley Hall Colliery Company, Wigan, and later was engaged on mining business in Australia.

Non-ferrous Metals.

Conditions in the non-ferrous metals market during the past week have been somewhat steadier, and virtually all sections have shared in the slight improvement, from the point of view of values, that has occurred since last report. Tin has followed up the advance recorded a week ago, and further ground has been gained after closing last week at a loss, but the net gain has not been substantial. The demand from industrial consumers of the metal has been on a moderate scale, and it is probable that a continuation of the steadier tone that has been in evidence in this section of the market during the past two weeks will result in increased confidence among users. The outlook with regard to prices is still rather uncertain, however, for the statistical position as disclosed by the February figures is not too strong, and a further net addition to the visible supplies of the metal in this country during the present month is anticipated. Inquiry for copper on this market has not been particularly active, and prices of standard brands were affected at one time by unfavourable advices from the United States as to consumption. The result was a loss when the market closed last week-end, but there has since been a recovery, and values at the time of writing are several shillings above what they were a week ago. In spite of a slow but steady recovery in lead prices during the past three weeks, bringing current quotations back to where they were in the middle of February, buyers are showing only subdued interest, and a further setback would not be surprising. From the point of view of demand the spelter section has been comparatively uneventful, but though supplies of the metal are plentiful enough, holders are offering cautiously and prices are about maintained on balance.

Iron.

Conditions in the pig iron market here are quiet again this week, a condition which has obtained almost to the point of monotony since the beginning of the present year. Current transactions have been confined to a few relatively small parcels for delivery over the next two or three months, and the absence of much in the way of inquiry at the moment would seem to exclude the hope of an early improvement in the conditions. In spite of this and of the fact that, judging from reports from some quarters, there seems to be a tendency on the part of certain consumers to delay specifying against contracts already on the books of makers, the opinion has been expressed this week that an expansion in the volume of buying may be looked for before long. Certainly, such a development is long overdue. In the meantime, except for the inevitable weak seller here and there, foundry iron prices have been steady all round, Staffordshire being quoted at 71s. 6d. per ton, delivered Manchester or equal distance, Derbyshire at from 72s. to 72s. 6d., North-East Coast at 78s., Scottish from 86d. to 87s. 6d., and hematite at 84s. Lancashire bar iron is in quiet request, but values are held at £10 per ton, delivered, for Crown quality, and £9 10s. for seconds.

Steel.

There has been a certain amount of buying of locomotive boiler-plates on this market of late, but it has slackened off again during the last day or two, and business in this section has been quiet, though values have kept up at from £9 15s. per ton for basic to £10 for acid plates. A moderate trade in tank plates and sectional materials at the regulated prices of £8 12s. 6d. and £7 17s. 6d., respectively, is being done, but it is almost entirely on an early delivery basis. With regard to steel bars there is not much buying going on, and current offers are at £8 17s. 6d. per ton for large diameters and £7 10s. for small re-rolled sorts. The recent firmness in the market for continental steels has, on occasion, brought out a little extra buying by users in this part of the country, but reports as to business during the last few days point to rather slow conditions again. Firmness is still a pronounced feature in this section of the steel market, and anything like normal delivery conditions are still extremely difficult to arrange. Continental sheet

bars are quoted at £5 10s. per ton, billets at £5 7s. 6d., ordinary plates at £7 7s. 6d., Siemens plates at £7 15s. to £7 17s. 6d., steel bars at £6 10s. and sections at about £6, for delivery to users' works in Lancashire, for cash against documents.

BARROW-IN-FURNESS.

Hematite.

There is no change in the condition of the hematite pig iron trade in the North-Western district. The present output is below normal, and only ten furnaces are operating in the whole of the district. A great proportion of the iron which is being produced is being used up by the steel makers in Barrow and Cumberland. The principal customers are in the Midlands, and they are only ordering for immediate requirements. There is little overseas trade, as far as the Continent is concerned. Business with America is spasmodic. A cargo has been dispatched from Barrow to Philadelphia. Makers' stocks are not going down very fast, and at those works where furnaces are in blast, there is a tendency for stocks to accumulate. The iron ore trade is quiet, and there are likely to be interruptions at some of the pits in Cumberland. Steel makers in this district have been kept going, but work has now reached the hand-to-mouth stage. As far as Barrow is concerned, orders from the L.M.S and L.N.E.R. enabled the steel works to carry on, and as these contracts were being finished, an order from the Colonies permitted the mills to continue. Further orders are urgently needed.

Shipbuilding.

The Orient Liner "Orford" has been completed by Vickers-Armstrong at Barrow, and has left the port on her trials. This is the third Orient liner which has been built within recent years, the two previous vessels being the "Orama" and "Otranto." The contract for the fourth is held by Vickers-Armstrong, and preliminary work is proceeding on it.

SHEFFIELD.

(From our own Correspondent.)

Reduced Steel Prices.

IT is possible this week to record signs of an improvement in the heavy steel trades of the district. The depression, which has been of a severe nature and of long duration, has been caused largely by foreign competition, and now that continental prices are rising, the prospect for local makers has brightened considerably. Everything possible is being done to press the opportunity. Hard basic billets have been reduced by 10s. per ton, a reduction which has probably been made with the idea of assisting the wire rod rollers after the big reduction in their quotations made a few weeks ago. There is very little difference now between the prices of continental and British wire rods, nor is there much advantage to be gained by buying billets from abroad. A temporary loss may be incurred, but if business develops, as it gives every promise of doing, this loss should soon be made good. A lot of extra work for steel has been placed this week, and the mills have been correspondingly busier, and as real economic production depends upon getting these plants into regular and continuous work, makers will soon recoup themselves if they can get the orders. Provided the present level of continental iron and steel prices is maintained, a great amount of business will come back to British makers. It should be noted that there is no change in the price of acid steel billets, and there is an open market for soft basic material. The crucible steel trade is making some headway, but the general position is not as sound as one would like.

Engineering Contracts.

The Brightside Foundry and Engineering Company, Ltd., of Sheffield, has secured two important contracts for its heating department. One is for the supply and erection of the whole of the cast iron circulating mains, together with the high-pressure steam pipes and fittings—275 lb. per square inch—and all the exhaust and feed pipes for the new electricity generating station at Oldham. The work includes all the valves, air compressor, turbine pumps, softening plant, tanks and rotary screen; in fact, the whole of the equipment, except the boilers and generating sets and condensers. The contract price is over £25,000. The other contract is for the complete equipment for warming and hot water service for the Mickleover Asylum for the Derbyshire County Council. The contract amount for this work is £9725, and includes calorifiers and circulating mains and the whole of the heating of the buildings, hot water supply, kitchen equipment, &c. Another contract recently secured by this firm for a similar installation is for the Dewsbury New Infirmary, and one for the Harton Board of Guardians, the price being £23,000. In connection with the super-power electricity stations, the company has secured some very substantial contracts in various parts of the country for the steam and circulating mains, and it is engaged on work at Edinburgh, Bury, Birmingham, Norwich, Marylebone, and several other places. With reference to the company's colliery engineering department, the new decking plant just completed by it for the Fife Coal Company is now working quite satisfactorily. This is the third installation of simultaneous decking plant for which the company has received orders, the other two being for the New Sharleston Collieries, Ltd., which plant is now in operation, and the Carlton Main Colliery, which is in course of manufacture.

Tools, Plate, and Cutlery.

Whilst the lighter trades generally are complaining of a slackness of work, useful orders continue to be booked, and though one or two important markets are buying poorly there is an optimistic feeling abroad. This is certainly so in the case of most classes of tools, and the enterprise which many local firms have shown in reorganising their oversea sales arrangements is undoubtedly bringing its reward. There is very little of the home trade in cutlery and plate coming through the ordinary shopkeeping channels, but several local firms are busy on contracts for shipping and catering companies.

Electrical Work.

One of the most prosperous branches of industry locally is that connected with the electrical undertakings. The large works at Attercliffe Common, Sheffield, belonging to Metropolitan-Vickers, Ltd., are working night and day on the manufacture of electric motors. Among the orders on hand are one or two of considerable magnitude, which will take some two years to complete. A large proportion of the work is for the export trade. Many steel castings are needed, and these are being supplied from the River Don Works of Vickers Ltd.

Bid for Huge Contract.

Mr. Charles Boot, chairman of Henry Boot and Sons, Ltd., engineers and contractors, of Sheffield and London, has left for Athens, where he will submit to the Greek Government his tender for the construction of the Struma Valley drainage scheme, which is to cost £8,000,000. In a letter sent to a Sheffield meeting explaining his absence, Mr. Boot stated that if he secured the contracts they would provide an enormous amount of engineering work for British workers. His only serious competitors were, he said, American, and he was quite sure he would have the hearty support of all Sheffield workers in seeking to secure those contracts in the interests of British trade.

Big Sheffield Scheme.

New schemes to be launched by Sheffield City Council will involve a capital expenditure during the year ending next March of £1,000,000, and when work in progress is added, the total capital expenditure for the year will exceed £2,750,000. Nearly £500,000 is to be spent on housing, £30,000 on markets, £60,000 on tramways, and £270,000 on electric supply. The Electric Supply Committee's expenditure will include mains, general extensions, £198,000; feeder cable and extensions, £50,000; water-cooling tower, £14,800.

Bridge Building.

Good progress has been made with the erection of a bridge over the river Ouse at Boothferry, near Goole. This bridge will provide a new through main road between the West and East Ridings, communications with which are at present obtained by a ferry boat. All the understructure work on both the Goole and Howden sides of the river has been practically completed. The eight cylinders for the carrying of the main weight of the bridge have been sunk, and the three smaller and permanent spans of the bridge are in position. The bridge, the estimated cost of which is about £110,000, is being constructed by the Cleveland Bridge and Engineering Company, Ltd., of Darlington, and Mr. C. E. Dixon is the engineer in charge of the work of erection. When complete the bridge will have a total length of approximately 700ft.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Exports Increasing.

ALTHOUGH the volume of business in the North of England iron and steel trade still leaves much to be desired, there are unmistakable signs of improvement. Continental prices have risen sharply since the beginning of the year, and, not only has the flood of imported material into the district been checked, but some progress has been recorded in the recovery of overseas trade. During February there was an increase of over 11,000 tons in the exports of pig iron, manufactured iron, and steel, from the Cleveland district, as compared with the figures for January, and the improvement was distributed over all branches of the trade. Since November there has been a steady improvement in the volume of Cleveland pig iron trade with Scotland, and the total of 7426 tons shipped last month represents the highest figure since March of last year, whilst 3470 tons were shipped to South Wales. Only 7465 tons went to foreign ports. This latter figure, however, promises to be substantially increased during the current month, as a number of sales for exports have already been arranged, and continental prices are now on such a level that Cleveland pig iron is on a competitive basis on a number of markets. The manufactured iron and steel exports totalled 66,870 tons, as compared with 57,361 tons in January, but there is still room for improvement, even if the average monthly figures for 1927 are to be equalled. The outstanding feature of the steel trade is the growing business with the South American republics, and it is interesting to note that the 16,902 tons of manufactured material shipped to the Argentine Republic last month constitutes a record in the history of the Cleveland trade. India has always been accounted Cleveland's best customer for steel, but Argentine requirements last month exceeded those of India, Ceylon and Burmah by 2670 tons.

Coal Mining Costs.

Colliery owners in Northumberland have received further relief as a result of the ascertainment on proceeds and costs in January, which regulates wages during the current month. But for the operation of the minimum wages clause in the county agreement, the minimum percentage addition to basis wages would be 31·09, as against 22·94 per cent. in February, an increase of 8·15 per cent. The new minimum percentage is 40, and therefore the deficiency to be made up by the owners is 8·91. Up to the end of February the county percentage was 80, and therefore if this figure had continued the deficiency would have been 48·91 per cent. The arbitrator's award in February reduced the minimum percentage from 80 to 40, and the collieries have got substantial relief. Nevertheless, changed as the circumstances are, there is still not sufficient yield to make up even as low a figure as 40 per cent. on the basis. There is some consolation, however, in the fact that the position is better on the month by 8·15 per cent. The ascertainment for the Durham coalfield shows that the wages payable this month will be at the rate of 41·92 per cent. on the basis, compared with 38·89 in February, an increase of 3·35 per cent. The new minimum percentage is 65, and therefore the deficiency to be made up by the owners this month is 23·08 per cent.

Tees-side Ironworks to Close.

By the decision of Gjers, Mills and Co., Ltd., to close down its Ayresome Ironworks, Middlesbrough, this week-end, about 400 men will be thrown out of employment. The inevitability of the company's course has been made apparent from the condition of the hematite market for many weeks, but the firm has kept operating as long as possible, accepting unremunerative prices as a penalty, in the hope that the improving situation as regards continental competition would bring a fresh stimulus. Developments in the hematite trade, however, have fallen below anticipations. Stocks are very heavy, and the absence of new business has forced the firm reluctantly to cease manufacturing. Two blast-furnaces will be blown out, reducing the number in operation on the North-East Coast to thirty-seven.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade continues to expand. The appreciable easing of continental competition is benefiting this district. Customers are more disposed to discuss business than they have been, and some of the contracts recently arranged are for delivery over periods well ahead. Economic conditions are, however, still causing anxiety. Orders for certain commodities are still being accepted at an actual loss. The restricted make of Cleveland pig iron does not quite cover current needs, with the result that the already much depleted stocks are still being drawn upon, and the healthy statistical situation enabled ironmasters to adhere firmly to their fixed prices. Local works continue to absorb a large proportion of the output, but deliveries to home consumers elsewhere are improving. Shipments so far already represent an increase on the corresponding period of last month, and the large number of export inquiries circulating promise more business in the near future. Prices are firm, No. 1 Cleveland pig iron being 67s. 6d.; No. 3 G.M.B., 65s.; No. 4 foundry, 64s.; and No. 4 forge, 63s. 6d.

Hematite Pig Iron.

East Coast hematite prices keep well below cost of production, but a rather marked upward tendency is noticeable, and while supply is still ample, the position is strengthened by further curtailment of output through two furnaces being put out of action. Both home and export sales are on an improved scale, and business promises to expand in the near future. Though transactions in ordinary brands are now little heard of, the quotation of 70s. for mixed numbers continues to rule market rates for the special qualities of iron that are being purchased.

Ironmaking Materials.

Sales of foreign ore are few, but merchants speak hopefully of the future, so far as prices are concerned. They do not name below 21s. 9d. c.i.f. Tees for best Rubio, and predict an early advance in price. Blast-furnace coke is in only moderate request, but makers are inclined to take a firm stand, and Durham good average qualities keep at 18s. to 18s. 3d. delivered at the works.

Manufactured Iron and Steel.

Business in the manufactured iron and steel trade is steadily expanding, and the general outlook is regarded as quite encouraging. Values are steady. Heavy steel consumers who have been purchasing only British material are reaping the advantage of the increased rebate, and the further concessions promise to induce firms who have been buying foreign products to pledge themselves to the sole use of steel of British manufacture. Export demand for plates and sheets is improving. There is also more business passing in semi-finished steel.

Less Foreign Material.

A feature of the statistics of imports of iron and steel for the past four months, presented at this week's meeting of the Tees Conservancy Commission, is that less and less foreign material is coming into the port. There has been a steady drop since November last, and, now that prices are on a more competitive basis, it is expected that the imports will be further restricted to the benefit of home industry. During the past four months only 3561 tons of pig iron were imported, as against 5233 tons in the corresponding period of 1926–27, and 54 tons in 1913–14. Plates, bars, angles, rails, sheets, joists, &c., brought into the river totalled 14,950 tons, as compared with 20,754 tons in 1926–27, and 7906 tons in 1913–14; while 53,693 tons of crude sheet bars, billets, blooms, slabs, &c., were imported as against 71,999 tons and 14,309 tons respectively. The grand total reached only 72,204 tons, as against 145,086 tons and 22,269 tons.

The Coal Trade.

There is no special feature in the Northern coal market. The demand remains dull, and supplies are freely offered. The collieries in Northumberland are not receding from the fixed prices they adopted about a month ago. So far their scheme has not received any serious setback, because there have been large quantities of coal to take out under contract, and there has been a fair amount of prompt business. If the hand-to-mouth trade is sustained, then the collieries may get along from week to week without much difficulty, although lost time at some of the pits is likely to occur. If the foreigner finds that he cannot buy at less than the present prices, and second-hand holdings become negligible, a change may come over the situation. In Durham the coalowners do not appear to have got beyond appointing committees to explore the possibilities of fixing export prices. It is perhaps a much

less easy county to work for the purpose than is Northumberland. There are merchants who believe that the present steam coal prices will break, and that about 13s. for best Northumberlands will rule before long. It is stated that first steam qualities have been offered in Scandinavia at 13s. These are speculative estimates, which may or may not prove true, but the fact remains that the pits cannot be expected to carry on at these prices and pay their way. The latest ascertainments in the Northern counties have shown that, even with the substantial cut in miners' wages, there is still a deficiency as between proceeds and costs. To reduce prices again and again to secure trade is a ruinous business, and the obvious stage has been reached when the collieries will have to decide, for the present at least, whether it would be not better to restrict the output to the demand and get a little better price for the coal than sell larger quantities at uneconomic prices. Second steams are held for a full 12s., and smalls are at 10s. Durham coking coals are moving on very quiet lines; output is fully up to requirements from all centres, and prices are easy at 13s. to 13s. 9d. Gas coals are well booked for prompt, and quoted steadily for all the month. Best qualities are quoted at 15s. 3d., and seconds at 13s. 3d. to 13s. 9d. Best bunker grades are in steady request at 14s. to 15s., but ordinary qualities are plentiful and weak in tone at 13s. to 13s. 6d. Supplies of all classes of coke are rapidly increasing, and, with a limited demand, prices are difficult to maintain. Gas coke is rather quiet and easy at 21s. to 21s. 6d. Patent oven coke is abundant at 17s. to 18s.; special grades are scarce at 23s. to 25s.; and beehive is scarce at 25s. to 28s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

So far as output is concerned the Clyde yards continue to make records. During the month of February sixteen vessels of 60,751 tons aggregate were launched, which, combined with the returns for January last, make a total of twenty-eight vessels of 116,759 tons aggregate, which, compared favourably with the previous best for the same period, and shows an increase of 23,328 tons. A number of fresh contracts were reported during February, but the total compares unfavourably with that of the launchings, consequently the position is unsatisfactory, as a continuance of present rates of output and booking must inevitably mean a considerable decrease in work on hand in the near future. Of the number of vessels launched in February eight were 4000 tons or over, one of 3400 tons, and seven below 1200 tons. Of the last mentioned four were small motor craft, two of which were of 6 tons each, with Parsons engines of 32 horse-power, and were built for the C.P.R. Company. Included in the list were the following:—"Vancolite," twin-screw motor tanker, 11,500 tons, for Imperial Oil, Ltd., Toronto; "Athelmonarch," twin-screw motor tanker, 8850 tons, for the United Molasses Company, Ltd., London; "Yarraville," oil tank steamer, 8627 tons, for the Vacuum Oil Company, Ltd., London; and the "Clan Macdonald," single-screw motor ship, 6100 tons, for Clan Line Steamers, Ltd., Glasgow. Contracts booked during February include four destroyers of about 1500 tons displacement for the Admiralty, an oil tank steamer of 12,750 tons, and a motor cargo vessel of 8800 tons.

Steel.

The general demand for steel continues on very moderate lines. Shipbuilding requirements are still below expectations, and while export demand for plates and sections has been somewhat better, the total amount of business passing is not large. Competition in light steel is very keen, and these departments are indifferenly employed. Prices are unchanged.

Steel Sheets.

Orders for black and galvanised sheets are disappointing. Rising prices of raw materials and strong competition make business increasingly difficult. Galvanised sheets have been severely cut in price, a lower figure than £13 per ton f.o.b. having been accepted for 24-gauge corrugated, but makers are not inclined to do business now on such a level of prices, which practically means a loss.

Iron.

Despite the advance in foreign prices, there is still no change in the local market, home prices being still a long way beyond a competitive level. Tube strips are comparatively busy. Re-rolled steelmakers have now to face increased charges for raw materials, and the outlook therefore for this department has not improved. Bar iron prices are unchanged, and re-rolled steel remains in the region of £7 15s. per ton home and £7 per ton export.

Pig Iron.

Actual business in Scottish pig iron has not increased, but the lessening of continental competition has established a more hopeful feeling. Meanwhile the restricted output is quite ample to meet all demands.

Coal.

The export market for coal continues dull; in fact, the demand is lower now than at any period since the present depression set in. Shippers are acting warily in view of the possible further curtailment of output, and shipping orders are very meagre. The collieries in Fifeshire and the Lothians are especially interested in the export trade, and in consequence are particularly hard hit by the existing depression. Practically all round, fuels are in need of fresh business, Lanarkshire splints alone providing any exception. Washed nuts are weak in all districts. Aggregate shipments amounted to 219,693 tons, against 246,324 tons in the preceding week, and 222,101 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

So far as the steam coal side of the industry is concerned, it can be said that the conditions are no worse, though, of course, there is room for considerable improvement. The anthracite trade at the moment is very quiet, but there are hopes that next month some improvement in this section will be experienced, inasmuch as shipments to Canada will be starting. The position at the moment can be gauged by the supplies of tonnage available. At the end of last week, taking the whole of the ports, there were round about thirty idle loading appliances, but on Monday this figure was reduced, as the result of week-end arrivals, to twenty-four, of which eight were at Cardiff, Penarth and Barry, whereas at Swansea, where anthracite coals are principally shipped, there were ten idle loading appliances, while at Port Talbot six were idle. The conditions at the ports where steam coals are shipped are not, on the whole, unfavourable; in fact, it may be said that a number of the collieries producing the superior grades of coals are very well occupied, and in a few instances have difficulty in avoiding demurrage, but it is better to be over-stemmed than to be without business. The only unfortunate part about it is that the prices at which the coals are disposed of are unremunerative, and the inquiry for fresh supplies is so comparatively meagre that sellers find it impossible to obtain higher figures. Shipments for the week ended the 2nd inst. were 419,323 tons, which was an increase of just over 50,000 tons upon the previous week, but whether this improvement is likely to be maintained is somewhat doubtful, as the record of chartering operations recently does not make very favourable reading. The total amount of tonnage reported as having been taken up during the week ended the 2nd inst. was slightly under 280,000 tons, which compares with rather more than 366,000 tons for the previous week, and with nearly 450,000 tons for the week preceding that. Judged therefore from this point of view it scarcely looks as if the present activity in shipments is going to be maintained for long.

Contract Business.

Tenders were opened at Cairo on Tuesday for the contract for 340,000 tons of steam coals for the Egyptian State Railways for delivery at Alexandria during the next six months. This order invariably attracts very great interest, and is very keenly competed for. News to hand shows that the lowest price put in for the whole quantity is 26s. 8d. c.i.f. Alexandria, submitted by Watts, Watts and Co., of London and Cardiff, whilst the nearest offers to this figure are 26s. 10d., 26s. 11d., and 27s. 1d., other prices ranging up to 28s. 9d. The business has not yet been definitely placed with the firm which has put in the lowest tender, as all offers have to remain good for a period of ten days. It is interesting to note that the tender of Watts, Watts and Co. is 6d. per ton less than the figure at which they secured the last contract, while previous to that the contract price for 125,000 tons for delivery over September, October and November last year was 28s. 2d. per ton c.i.f., and other contracts entered into by these railways earlier in the year were at 32s. 3d., 33s. 5d. and 31s. 11d. per ton c.i.f. With regard to the French Marine inquiry for 100,000 tons of steam coal or patent fuel, it is reported that this contract has been placed for French fuel. Tenders for 100,000 tons of small coals for the Portuguese State Railways were due to be in on the 8th inst.

Coal Stabilisation Scheme.

The committee which has been dealing with the proposed scheme for the stabilisation of the coal market recently completed its labours so far as the classification of coals, &c., is concerned, and full details were sent out to the various colliery undertakings, it being understood that the date for the introduction of the scheme was to be the 19th inst. Whether this date will be adhered to remains to be seen, as the official report of a meeting of the Committee held at Cardiff on Monday states that the Committee received the replies from the colliery companies as to whether or not they would join the proposed new Association. In view of the limited time which was allowed to colliery companies to forward their replies, a sufficient number had not been received to enable the Committee to arrive at a final decision. A communication is being addressed to those companies who have not sent a reply, and a further meeting of the Committee will be held early next week. The report adds that the tonnage of the colliery companies who have given their assent in favour of the scheme was considered by the Committee to be satisfactory.

Coal Trade Finances.

At the end of last week particulars were issued regarding the quarterly ascertainment which covers the three months, November, December and January. The figures show that the position is worse than it has been in any period since the resumption of work after the 1926 stoppage. During the three months in question the industry incurred a loss of £761,312, which is equivalent to nearly 1s. 6d. per ton on the output, while the deficiency amounted to £1,633,363. As a comparison it may be stated that the loss in the first quarter of last year was £216,776, in the second quarter it was £573,929, and in the third quarter ended October of last year itwas £656, 636. The aggregate loss for the past twelve months consequently is well over £2,200,000, while the total deficiency amounts to £5,109,621. The wages of the workmen under the terms of the 1926 agreement remain for the next three months at 28 per cent. above the 1915 base rates, which is the minimum, though on the returns of the industry they would only be entitled to a rate of wages nearly 10 per cent. below the 1915 standard base rates.

Current Business.

The market from day to day has displayed very little life, though the undertone has shown some steadiness. This remark applies more especially to the superior grades of coal, which are for the time being well sold. Some of the leading Monmouthshire qualities are also slightly better placed for orders, but unfortunately the position all round is not so satisfactory, as the demand for inferior large coals shows no material expansion. Small coals are well upheld, as also are sized descriptions, but patent fuel and coke are still on the quiet side.

CONTRACTS.

THE "DE MAAS" SHIPBUILDING COMPANY, Slikkerveer, Holland, has secured contracts for six barges of 300 tons capacity each, structural work for a bridge, a pontoon and an oil tank lighter of 730 tons capacity.

THE County Council of the West Riding of Yorkshire has placed an order with Millars' Machinery Company, Ltd., for a Millars' portable asphalt plant, 10 tons per hour capacity, together with melting tanks and accessories.

THE GENERAL ELECTRIC COMPANY, Ltd., has secured a contract from the Southern Railway Company for the supply of a large number of Osram lamps (including train lighting lamps) over the period March 1st to August 31st, 1928.

THE LONDON ELECTRIC FIRM, South Croydon, has secured an order for some searchlights 7ft in diameter. These searchlights are claimed to be larger than anything that has hitherto been constructed in this country, and amongst the largest ever made in any other country.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received an order from the Southern Railway for signalling apparatus for the Lewisham connecting lines, the principal items of which are as follows:—109 two-element vane track relays, 382 single-element vane line relays, 28 two-element three-position vane point indicating relays, 72 apparatus cases, 60 cable joint boxes, 54 track service sets, 110 resonated impedance bonds and connections, 17 combined lever lock and circuit controllers, main transformers and switchgear, transformers, &c.

THE ENGLISH ELECTRIC COMPANY has secured through its agents, the Associated British Manufacturers (Egypt), Ltd., a contract from the Ministry of Public Works, Egypt, which amounts to about £185,000. It is for the complete plant for the Belqas Power Station, and includes three "English Electric," 2500 kW turbo-alternator sets, the necessary transformers, switchgear, &c., boiler plant and coal-handling plant. It is understood the Belqas Station, which is to be situated 14 miles north of Mansura on the Belqas Canal, will supply power for the operation of the new pumping stations in connection with the Egyptian Government's irrigation schemes, and for conversion of some of the existing stations from engine drive to electrical drive.

CATALOGUES.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Huddersfield.—Leaflet illustrating a fixed jaw patent gear tooth caliper.

BLACKMAN EXPORT COMPANY, Ltd., 374, Euston-road, N.W. 1.—Booklet dealing with the Blackman Type propeller fans.

THE BIRMINGHAM SMALL ARMS COMPANY, Ltd., Birmingham.—Particulars of the "B.S.A." No. 10 centreless grinding machine.

CROMPTON-PARKINSON, Ltd., Chelmsford.—Specification No. 2070, "Semi and Full Automatic Rotary Converter Sub-station Equipments."

THE LUNKEN COMPANY, Ltd., 35, Great Dover-street, S.E. 1.—Illustrated catalogue and price list of valves, grease cups, lubricators, cocks, injectors, &c.

KING'S PATENT AGENCY, Ltd., 146a, Queen Victoria-street, E.C. 4.—The seventeenth edition of "King's Handbook on Patents, Trade Marks, Designs and Copyright."

S. F. BOWSER AND CO., Inc., Windsor House, Victoria-street, S.W. 1.—A booklet entitled "Modern Lubrication," describing in detail "Bowser" automatic lubricators and oil purifiers.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—In view of the comparatively small number of members who expressed a desire to take part in the proposed summer meeting in Norway next June, it has been decided not to proceed with the arrangements.

OLD CENTRALIANS.—On Friday, March 2nd, the Old Centralians held their annual dinner. In a sense it was an experiment, for it was served, for the first time, in the refectory of the "Union." It did credit to the staff, for it was excellent in every way. The attendance was good. Mr. Tripp was a genial chairman, and the speeches were bright and breezy. The event of the evening was the unexpected arrival of Dr. Armstrong right at the end. He had just come from the "Old Finsbury" dinner, and in a speech full of "Armstrongisms," he urged the two "old boys" associations to join forces. A suggestion which was well received.

EX-BRITISH WESTINGHOUSE ASSOCIATION.—On Friday, March 2nd, at the Hotel Cecil, London, Mr. A. McKinstry presided at the tenth annual reunion of the Ex-British Westinghouse Association; the attendance nearly reached the "record" number present at the first dinner, and Ex-British Westinghouse men from all parts of the country turned up to meet colleagues of the old Trafford Park days. The occasion was made one for a presentation of a silver tea service and cigarette box to Mr. L. S. Richardson, in recognition of his untiring services as hon. secretary of the Association during ten years. The next reunion will be at Hotel Cecil, London, on Friday, March 8th, 1929.

COOPERS HILL WAR MEMORIAL PRIZE AND MEDAL.—The above-named prize, which was founded by members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the war, is awarded annually by the Institution of Civil Engineers and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. The prize, which consists of:—(*a*) A Bronze Medal; (*b*) A Parchment Certificate of Award; (*c*) A Money Prize of the value of about £25, is awarded for the best paper on a professional subject selected by the Council making the award. The triennial award falls this year to the Council of the Institution of Electrical Engineers, which has selected the following nine subjects, and members are invited to submit for consideration a paper on any one of them:—"The Use of Electricity in Public Works," "Hydro-electric Power in Rural Districts," "Electrification of Railways," "Electricity in Agriculture," "Electric Railways in the Empire Overseas," "The Line and Wireless Communications of India," "Overhead Lines in Rural Districts," "High-voltage Cables (20 kV and Upwards)," "Empire Wireless Communication." Papers submitted must be specially written for the purpose of the competition and reach the secretary of the Institution not later than October 1st, 1928. Only corporate members of the Institution who were under thirty years of age on January 1st, 1928, are eligible.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/- to 21/-
(1) Spanish	19/- to 21/-
(1) N. African	19/- to 21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	21 9

PIG IRON.

	Home. £ s. d	Export. £ s. d.
(2) Scotland—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 10 0	3 10 0
No. 1	3 10 6	3 10 6
Cleveland—		
No. 1	3 7 6	3 7 6
Silicious Iron	3 7 6	3 7 6
No. 3 G.M.B.	3 5 0	3 5 0
No. 4 Foundry	3 4 0	3 4 0
No. 4 Forge	3 3 6	3 3 6
Mottled	3 3 0	3 3 0
White	3 3 0	3 3 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
„ „ Foundry	3 3 6	—
(3) Northampton—		
Foundry No. 3	3 0 0 to 3 1 0	—
Forge	2 14 0	—
(3) Derbyshire—		
No. 3 Foundry	3 4 0 to 3 4 6	—
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0	—
No. 4 Forge	3 3 6	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (*a*); 4 5 0 (*b*); 4 8 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	10 0 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Lancs.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 7 6 to 10 5 0	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0	—
Gas Tube Strip	11 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 12 6	8 15 0
Sheets (Gal. Cor. 24 B G.)	13 2 6	13 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 2 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
Manchester—		
Bars (Round)	8 17 6	—
„ (Small Round)	7 10 0	—
Hoops (Baling)	10 5 0	10 0 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6	—
„ (Lancs. Boiler)	10 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 to 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 10 10 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars	7 7 6 to 8 0 0	—
Billets and Sheet Bars	6 0 0 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	17/9 to 18/3
Block Tin (cash)	231 17 6
„ (three months)	234 2 6
Copper (cash)	61 0 0
„ (three months)	60 17 6
Spanish Lead (cash)	20 5 0
„ (three months)	20 12 6
Spelter (cash)	25 3 9
„ (three months)	25 1 3
Manchester—	
Copper, Best Selected Ingots	66 0 0
„ Electrolytic	67 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 1 0
„ Condenser, lb.	0 1 2
Lead, English	21 10 0
„ Foreign	20 7 6
Spelter	25 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 15 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 7 6	7/-
„ „ 8 p.c. to 10 p.c. „	£22 5 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£35 0 0	12/-
„ „ „ 1 p.c. carbon	£40 10 0	15/-
„ „ „ 0·70 p.c. carbon	£50 0 0	17/-
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/11 per lb.	
Ferro Manganese (per ton)	£13 10 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 17 6 scale 5/- per unit	
„ „ 75 p.c.	£20 10 0 scale 6/- per unit	
„ Vanadium	14/3 per lb.	
„ Molybdenum	4/11 per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£172	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/9
„ „ Ell	14/6
„ „ Splint	16/9 to 17/6
„ „ Trebles	13/6
„ „ Doubles	12/6
„ „ Singles	11/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/-
„ „ Jewel	15/6
„ „ Trebles	14/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/6 to 12/-
Screened Navigation	18/-
Trebles	12/6
Doubles	12/-
Singles	11/-
Lothians—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/-
Trebles	12/3
Doubles	11/6
Singles	11/3

ENGLAND.

(9) N.W. Coast—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
Northumberland—	
Best Steams	13/6
Second Steams	11/9 to 12/-
Steam Smalls	10/-
Unscreened	11/9 to 12/-
Household	21/- to 27/-
Durham—	
Best Gas	15/3
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	18/6 to 19/-

Sheffield—	Inland.
Best Hand-picked Branch	27/6 to 29/6 —
Derbyshire Best Bright House	20/6 to 21/6 —
Best House Coal	19/- to 20/6 —
Screened House Coal	16/- to 17/6 —
„ „ Nuts	15/- to 16/- —
Yorkshire Hards	14/6 to 15/6 —
Derbyshire Hards	14/- to 15/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland)	13/- at ovens —
Furnace and Foundry Coke (Export), f.o.b.	17/- to 18/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/- to 19/6
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/- to 18/6
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	17/- to 17/3
Western Valley Large	16/9 to 17/-
Best Eastern Valley Large	16/9 to 17/-
Ordinary Eastern Valley Large	16/3 to 16/9
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	11/- to 12/6
Washed Nuts	18/- to 23/-
No. 3 Rhondda Large	19/6 to 20/-
„ „ Smalls	14/9 to 15/3
No. 2 „ Large	16/- to 16/6
„ „ Through	14/6 to 15/6
„ „ Smalls	12/6 to 13/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	21/6 to 23/-
Pitwood (ex ship)	27/3 to 27/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	30/- to 32/6
Seconds	24/6 to 27/6
Red Vein	20/6 to 25/-
Machine-made Cobbles	35/- to 40/-
Nuts	37/6 to 42/6
Beans	23/- to 27/-
Peas	17/- to 18/-
Breaker Duff	8/6 to 9/-
Rubbly Culm	9/3 to 9/9
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	9/6 to 10/6
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Industrial Protection.

THE metallurgical trades are being placed in a distinctly stronger position by the action of the *comptoirs* in advancing prices, and now that the sheet mill owners have formed a similar association the reorganisation of the industry may be said to be complete. It is doubtful, however, whether prices can go much higher, for the recent active demand following upon the advanced quotations has now ceased, from which it is assumed that the buying was mainly for stock, and that merchants and others are not disposed to commit themselves further. Mill and forge owners are fairly well employed, and some good contracts have been received, including one for the supply of 40,000 tons of rails, sleepers and accessories for the railways to be constructed in Anatolia by the Swedish group which has for a long while past been negotiating for concessions in Turkey. While the higher prices on the home market have placed French producers in a better position for quoting abroad, they are by no means acceptable to the engineering and other consuming industries, and the situation in which these industries find themselves is so far from being satisfactory that the Government has given in to the pressure that has been brought to bear upon it to provide further protection. The import duties have been increased all round, and they would have been augmented still further for many classes of goods if a limit had not been fixed for them by the treaty with Germany last year. The wave of protectionism which has swept over Parliament on the eve of the general elections has caused dismay amongst commercial people, who fear that it will entail a further increase in the cost of living and may, it is affirmed, provoke retaliation from Great Britain and other countries. Industry is now passing through an experimental phase in the matter of increased protection, and while many people are prepared to watch the result of the experiment, others believe that it will inevitably cause complications. Meanwhile some appearance of activity is given to the engineering industries by the placing of orders by the railway companies at the instigation of the Government. Locomotive builders have had distributed amongst them orders for 130 locomotives, and others are to follow, while the wagon builders have also been supplied with work.

South American Air Service.

The new postal air service between Toulouse and Buenos Aires was started during the week and may be regarded, in a way, as an achievement, for it has necessitated a strenuous amount of organisation in order to get the mails over within the period fixed by the option accorded by the Brazilian and Argentine Governments to the Latécoère Company. At present it is only partially an air line. The mails are carried by aeroplane from Toulouse to Saint-Louis in Senegal and thence to the Cape Verde Islands, where they are transferred to vessels supplied temporarily by the Navy for conveyance to the island of Fernando-Noronha, at which place they are again taken over by aeroplanes for Buenos Aires. The journey occupies about seven and a-half days. It is intended eventually to replace the vessels by seaplanes, and it is probably in view of that substitution that the official inauguration of the complete air service has been postponed until September next. About that time it is expected that Germany will be beginning her service of airships, and probably of flying boats, to South America, and although France has secured the credit of making the first move it is obvious that competition for the air traffic to South America in the future will be keen.

Paris Sewage.

The problem of dealing with a million cubic metres of used water a day is still occupying the attention of Paris municipal engineers who are extremely embarrassed by the refusal of the towns along the valley of the Seine to permit the laying out of new sewage farms in their areas. The policy of the Municipal Council has always been to extend the farms as offering the most economical and efficient means of disposing of the sewage, and it still hopes to overcome local objections, although, it appears, with little chance of success. Considerable areas have been purchased by the Council in the Seine Valley for that purpose. Meanwhile experiments continue to be carried out with different methods of sewage treatment. In one suburban town percolating beds have been installed with success, and the oxidation of the sewage by air is effected at the works at Colombes, but the difficulty lies in dealing with the considerable quantities of resultant solid matter. It is still proposed to construct further huge mains along the bank of the Seine, but it is obvious that nothing can be done until the Municipal Council is able to adopt some method of sewage treatment which will be economical and efficient and will not arouse local opposition.

Foreign Trade.

Until a year ago metallurgical firms and, to a less extent, constructive engineers depended for business mostly upon the foreign demand, and with the depreciation of the franc they were in a particularly satisfactory position to compete in other markets. Since the stabilisation of the franc they have continued to develop their export trade, although at the expense of low prices. The latest returns show that the prices now being obtained must be very low. During January the exports declined considerably as compared with the previous month, although they were higher than those of the first month of 1927. Manufactured goods declined by 41,180 tons and the drop in values was 478 million francs. The exports of "material necessary for industry," including blooms and billets and rolled iron, increased by 199,405 tons, while the value contracted by no less than 304 million francs. The returns show that the French pay more for what they import and get less for what they sell abroad.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

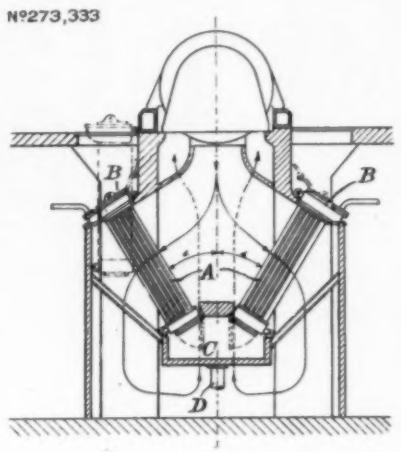
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

273,333. June 27th, 1927.—IMPROVEMENTS IN AND RELATING TO COOLING SYSTEMS FOR DYNAMO-ELECTRIC MACHINES, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

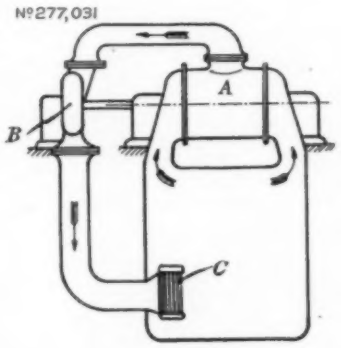
This invention relates to the arrangement of coolers for electric generators, and it is claimed that as regards flow of air, space required, and accessibility, the scheme presents considerable



advantages over other arrangements. As shown in the drawing, the coolers A are inclined, the upper headers B being accessible for cleaning purposes. The lower headers open into a space C, which is not connected with the air circulating system. Mud and water can be run away through the pipe D. The inventors point out that on following the direction of the flow of air, as indicated by the arrows, it will be seen that the conditions in this respect are very satisfactory.—*January 26th*, 1927.

277,031. September 3rd, 1926.—IMPROVEMENTS IN CIRCULATORY COOLING SYSTEMS FOR DYNAMO-ELECTRIC MACHINES, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

In accordance with this invention, the generator A is cooled by a separate fan B, which is mechanically driven from the

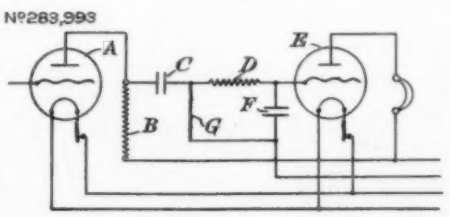


generator. The invention is characterised by the feature that the inlet and outlet to and from the generator are on opposite sides of the machine, so that crossing of the air passages is unnecessary and counter-flow of the air is avoided. It will be understood that C is the usual air cooler.—*January 26th*, 1928.

ELECTRICAL APPLIANCES.

283,993. October 15th, 1926.—IMPROVEMENTS IN OR RELATING TO RESISTANCE-COUPLED AMPLIFIERS FOR LOW AND MEDIUM FREQUENCIES, *Harold Wade, of* 111–112, *Hatton-garden, London, E.C.* 1.

This invention is concerned more particularly with resistance capacity amplifiers for audio frequencies, but it is also applicable

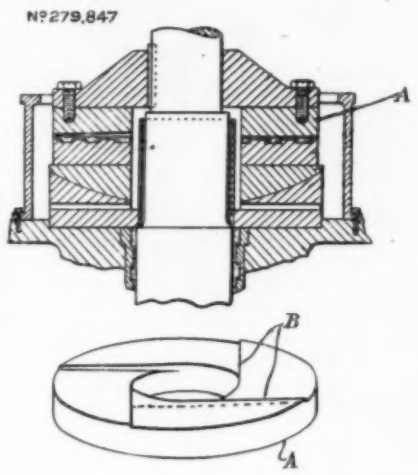


to amplifiers working at medium frequencies in the neighbourhood of 50,000 oscillations per second. It is known that in addition to the audio-frequency oscillations in the plate circuit of detector valves, there are nearly always high-frequency components. On amplifying the low-frequency currents, the high-frequency oscillations are also amplified, and may give rise to distortion of the sound. The object of this invention is to construct a resistance amplifier so that the high-frequency components will not exercise any appreciable influence on the controlling grids of the amplifying valves. The plate circuit of the triode A includes an anode resistance B, the plate end of which is connected through a grid condenser C in series with an ohmic resistance D to the grid of the triode E. In addition, the grid of the valve E is connected across a small auxiliary condenser F to a point of constant (negative) potential. The connecting point between the resistance D and the grid condenser C is connected through a leakage resistance G to the same point of constant potential. The small auxiliary condenser F presents a practically infinitely large impedance to low and medium-frequencies, so that the oscillations of these frequencies make their way almost exclusively across the grid condenser C, and the leakage resistance G. Thus by far the greater portion of the potential drop of the oscillations occurs in the leakage resistance G which must be large compared with the ohmic resistance D. On the contrary, the high-frequency oscillations meet with much less impedance in the condenser F than in the leakage resistance G, and consequently make their way across the condenser, the potentinl drop of the oscillations taking place almost entirely within the ohmic resistance D. The grid of the valve E is connected to the exit end of the resistance D.—*January 16th*, 1928.

TRANSMISSION OF POWER.

279,847. October 24th, 1927.—THRUST BEARINGS, *The British Thompson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.* 2.

The inventors state that they have found it to be entirely practicable so to construct the rubbing surfaces of a thrust bearing that the lubricant is circulated between them in sufficient quantity and in proportion to the speed at which they run to carry off the heat as generated and avoid all dependence on the metal parts to conduct it away from the bearing surfaces. For this purpose the bearing surface A is divided into quadrants by the removal of portions of the metal beginning at lines B disposed tangentially to the inner periphery and gradually tapering off along helical outer and inner peripheral guide lines

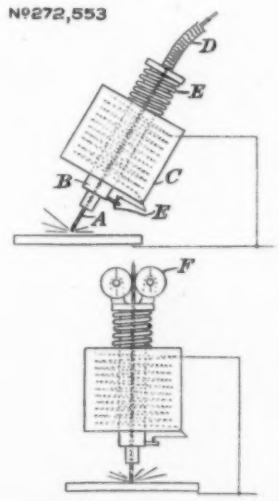


toward the following segment. The depth to which the metal is removed, which is in any case only a few mils, is much less at the outer periphery than at the inner, so that as the runner rotates the oil under centrifugal action enters freely from the centre of the bearing into the spaces between the stationary and movable members, but is throttled or resisted in its passage between them by the contraction of the spaces toward the outer periphery. By reason of the throttling of the centrifugally pumped oil, the spaces formed by the removal of the metal from the surface of the runner are maintained full of oil under pressure which is proportional to the speed at which the bearing operates, the consequence of which is that all parts of the wedge-shaped oil films between the bearing members are constantly and freely renewed by cool oil.—*January 26th*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

272,553. June 13th, 1927.—DEVICES FOR STARTING THE ARC IN AUTOMATIC ARC-WELDING MACHINES, Robert Sarazin, of 48, Boulevard d'Asnieres, Neuilly-sur-Seine, France.

According to this invention, the electrode wire A passes through the core B of the coil C of an electro-magnet embodied



in the electrode holder. The flexible tube D serves as a cover for the wire, and is fixed to the electrode holder. The electro-magnet is connected in parallel with the arc and the circuit is controlled by means of a rapid break E. The ampère turns of the electro-magnet are chosen so that the apparatus starts

vibrating under the starting voltage of 40–50, and to cease vibrating at the welding voltage of 20 to 25. If, however, the operator desires to prolong the vibration of the device, after the arc has been started, the spring E is adjusted. The invention is said to facilitate starting the arc. In the modified arrangement shown in the lower illustration, driving rollers F are employed for feeding the electrodes forward. In the case of the other arrangement, it is stated that the wire is forced through the tube D by means of an actuating device having a suitable speed.—*January 26th*, 1928.

284,148. July 22nd, 1927.—MACHINING TURBINE BLADES, John I. Thornycroft and Co., Ltd., Thornycroft House, Smith-square, Westminster.

This machine is intended for milling the back faces of steam turbine blades to a taper and depends for its action on two cams A and B. The blade C is held in a chuck D, and is operated upon by the milling cutter E. The chuck is mounted upon a

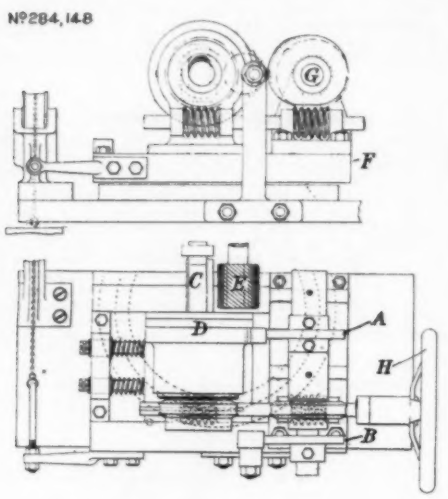
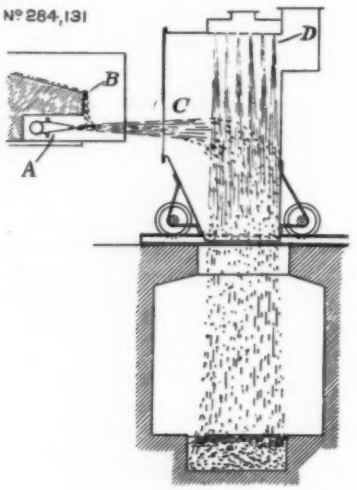


table F which can rotate about a vertical axis, and also slide transversely to the spindle of the cutter. The chuck shaft and the cam shaft G are geared together by means of the worm gearing shown, and are operated by the hand wheel H. As the blade is fed up to the cutter the cam A determines the profile of its cross-section while cam B rotates the turntable and fixes the taper.—*January 26th*, 1928.

METALLURGY.

284,131. June 7th, 1927.—DISINTEGRATING LIQUID ALUMINA. *A. L. Mond*, 19, *Southampton Buildings, Chancery-lane, London, W.C.* 2.

In this specification it is pointed out that alumina obtained by fusion is an extremely hard material which can only with great difficulty be disintegrated to the degree of fineness required for the electrolytic manufacture of aluminium. The present invention is based on the recognition that molten alumina contracts considerably during very rapid solidification with the formation of very small crystals. It has been ascertained

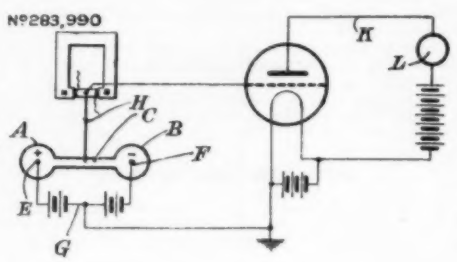


that when suitably subjecting molten alumina to rapid cooling by means of water or other suitable liquid, bodies can be obtained in which the individual crystals are contained in the small size requisite for the electrolysis, such crystals being fritted together only at their edges or corners and being consequently very easily separable from each other, for example, in an edge runner mill or in other simple disintegrating apparatus. The apparatus for carrying out the process is shown in the illustration, and comprises air jets A which blow the stream of molten alumina coming over the edge B into the chamber C, where it is subjected to the cooling action of the water spray D.—*January 26th*, 1928.

MISCELLANEOUS.

283,990. October 11th, 1926.—IMPROVEMENTS IN OR RELATING TO MEANS FOR AMPLIFYING SMALL MOVEMENTS, Creed and Co., Ltd., of Telegraph Works, Croydon; Frederick George Creed, of the same address, and Axel Orling, of 169, Mitcham-lane, Streatham, London.

In the arrangement shown, a potentiometer is used comprising two vessels A and B connected together by a trough C of small cross section and provided with stationary electrodes E and F connected with the opposite poles of an electric battery G, the vessels and trough being charged with a liquid of small electrical conductivity, such as tap water. A movable electrode H extends into the electrolyte in the trough. A small movement of the movable electrode H causes a variation of potential to be imparted to that electrode. By connecting the movable electrode H to the grid of a thermionic valve and the centre of the battery G to the filament of the valve, movement of the electrode H to either side of a predetermined normal position, corresponding to the normal or mid position of the primary movable device, will cause an increase or decrease in potential on the grid and a consequent variation in the current



strength in the anode circuit K of the valve, which, of course includes a high-tension battery. The movable electrode H is operated directly from a primary movable device. L is an electro-magnetic or other device, which is affected by the variation of the current strength in the anode circuit K.—*January 11th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. "Special Alloys in Relation to the Corrosion Problem," by Mr. W. R. Barclay. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM DISTRICT ASSOCIATION; INSTITUTION OF MECHANICAL ENGINEERS: MIDLAND BRANCH; INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Chamber of Commerce, New-street, Birmingham. Annual joint meeting. Lecture, "Engineering Works in India," by Mr. F. Palmer. 6.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Limit System in Relation to Production and Inspection, and Some Inspection Problems," by Mr. L. Nicholson. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Air Compressors," by Mr. E. S. Huntingford. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Room 14, Temperance Institute, Keighley. Lecture, "Recent Developments in Precision Grinding Machines," by Mr. T. R. Shaw. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Mining Institute, Newcastle-upon-Tyne. Paper, "Measurement of Power," by Mr. J. S. Brown. 6 p.m.

PHYSICAL SOCIETY.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Thirteenth Guthrie Lecture, "Electrodeless Discharge Through Gases," by Sir Joseph Thomson. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Sun's Outer Atmosphere," by Mr. E. A. Milne. 9 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Indian Section meeting. "The Air Routes of India," by Lieut.-Col. A. E. Edwards. 4.30 p.m.

SATURDAY, MARCH 10TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Transformation of Matter," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 12TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Queen's Hotel, Birmingham. Paper, "Some Notes on the Single Sleeve Valve," by Mr. G. L. Ensor. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. Paper, "Insulating Oils for High-voltage Cables," by Messrs. T. N. Riley and T. R. Scott. 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Lecture, "Some Technical Problems of Broadcasting," by Captain P. P. Eckersley. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Wave Mechanics" (3), by Dr. E. Schrödinger. 5.15 p.m.

TUESDAY, MARCH 13TH.

ILLUMINATING ENGINEERING SOCIETY.—Lecture Theatre of Holophane, Ltd., Elverton-street, London, S.W. 1. Paper, "The Manufacture and Properties of Glass and their Application to Illuminating Engineering," by Mr. S. English. 6.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "Foundry Conditions," by Mr. W. H. Meadowcroft. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Hotel, Edinburgh. Paper, "Practice and Progress in Combustion of Coal as Applied to Steam Generation," by Mr. F. H. Rosencrants. 7 p.m.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower-hill, London, E. 1. Paper, "Recent Developments in Propelling Equipment Practice of Reciprocating Engined Steamers," by Mr. G. R. Hutchinson. 6.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Natural Gas of South Persia, Process, Development and Exploitation," by Lieut.-Col. S. J. M. Auld. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Presidential address, by Mr. H. O. Dixon. 4 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "The Erosion of Guns from the Metallurgical Standpoint," by Dr. H. Moore. 7.30 p.m.

WEDNESDAY, MARCH 14TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Students' meeting. Paper, "The Belgian Railways," by Mr. H. M. Pearson. 6.30 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper, "Wells and Well Boring," by Mr. G. A. Hughes. 7.30 p.m.

OVERHEAD LINES ASSOCIATION.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "Joint Use of Wood Pole Lines for Electricity Supply and Communication Systems," by Mr. E. S. Byng. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Wave Mechanics" (4), by Dr. E. Schrödinger. 5.15 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Lead Acid Cell: Its Place in Modern Industry," by Mr. H. G. Brown. 8 p.m.

THURSDAY, MARCH 15TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. "High Tensile Bronze," by Mr. W. Lambert. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Some Notes on Poppet Valves," by Mr. L. A. Green. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Some Considerations of the Economics of Electric Power Production," by Mr. W. T. Townend. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Optics and Chemistry," by Dr. J. J. Fox. 5.15 p.m.

FRIDAY, MARCH 16TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Paper, "The Reorganisation of Crewe Locomotive Works," by Captain H. P. M. Beames. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—92, Victoria-street, London, S.W. 1. Metropolitan District meeting. 6 p.m.

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS.—Lecture Theatre of the Royal United Service Institution, Whitehall, London, S.W. 1. Lecture, "The Development of High-speed Aircraft," by Major J. S. Buchanan. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Chairman's address, "An Outline of Petroleum Distribution," by Mr. W. M. Hurrell. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Quantum and Relativity Theories of Light," by Professor E. T. Whittaker. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical College, West Bromwich. "Metallurgical Defects and Failures in Engineering," by Professor D. Hanson. 7.30 p.m.

SATURDAY, MARCH 17TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Ipswich. 2 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Transformation of Matter," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 19TH.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper "A Railway Journey in Spain," by Mr. W. A. Willox. 7.30 p.m.

TUESDAY, MARCH 20TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—The Engineers' Club, Waterloo-street, Birmingham. "Non-Ferrous Tubes," by Mr. W. E. Ballard. 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "The Development of the Fiat Marine Oil Engine," by Ing. Giovanni Chiesa and Mr. D. M. Shannon. 7.30 p.m.

WEDNESDAY, MARCH 21ST.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Modern Typewriter and its Portable Future Development," by Lieut.-Commander R. T. Gould. 8 p.m.

FRIDAY, MARCH 23RD.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Mechanical Handling of Goods," introduced by Mr. J. H. Walker. 7 p.m.

MONDAY, MARCH 26TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Annual lecture, "The Trend of Modern Steam Locomotive Design," by Mr. R. E. L. Maunsell. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

LIEUT.-COLONEL C. HARDIE, D.S.O., M.I.E.E., has been appointed general manager of the Chelmsford Works of Crompton Parkinson, Ltd.

GEORGE REVEIRS, Ltd., of 2–5, Greystoke-place, Fetter-lane, London, E.C. 4, asks us to announce that its telephone number has been changed from Central 5120 to Holborn 3920.

WALKER, CROSWELLER AND CO., 54–58, Queen Elizabeth-street, London, S.E. 1, inform us that they have taken over the sole selling rights for the British Isles and certain countries abroad of the "Dielectrimeter." The "Dielectrimeter" is a portable instrument used for testing the dielectric strength of oils which was hitherto sold by the Empson Electrical Engineering Company, Ltd.

THE new edition of the General Electric Company's bound catalogue calls for exceptional mention. It has a very suitable title, "Everything Electrical." It is now some years since the company published a bound catalogue of all its products, and the new edition consists of nearly 1000 pages of price lists, illustrations and descriptive matter of practically all the leading lines of electrical and wireless engineering equipment. The volume contains examples of plant for the largest generating stations, telephone exchanges and power transmission schemes, down to the smallest accessories for wireless sets. There is also an extensive glossary of technical terms, wiring and conversion tables likely to be of great service to electrical engineers. The book is finished with an admirably compiled alphabetical and numerical index, which reduces to a minimum the time usually lost in searching for one's requirements.